In Focus

THE THOROUGHNESS with which the Hale reflector was planned is evident when it is realized that no major change has been made in the details shown by such early cutaway drawings as the back-cover illustration this month, dated 1937 by the artist, Russell W. Porter.

To the extreme right of the picture is the coude diagonal mirror, mounted on top of the tube that extends through the center of the primary mirror (see back cover, September, 1948, issue). This optical flat measures 36 by 53 inches; it can be turned and adjusted to direct the light from the Cassegrainian secondary mirrors to the coude foci.

Most important of these is in the constant-temperature spectrograph room located behind the south polar bearing, but when the telescope is pointed at objects north of 50° declination, the mirror directs the light to two auxiliary plane mirrors and thence into the spectrograph room (see back cover, January, 1948, issue).

Built into the side of the tube itself is the "bicycle-spokes" system of supporting the 125-ton tube. This method of support affords slight flexibility laterally to offset any binding effect of the yoke. The declination axis is supported on two sets of roller bearings, the one nearest the tube having a single-ball race, the other bearing being a double-ball race. Up to this point the two declination bearings are identical, but the west bearing is used as a passage for the wiring to the controls of the telescope, while the east bearing is kept clear for possible use as shown in this picture: although it is not being currently worked on, a spectrograph can be mounted and operated in the 10½-foot hollow yoke arm.

In the lower right corner of the drawing is a segment of the 173-inch-diameter, 720-tooth worm gear used to drive the 500-ton tube in declination. The driving elements for declination are principally contained in a box in the west yoke tube. The drive worm housing is frictionally held in a reference position.

Added in press: According to **Time** magazine for December 13, 1948, Dr. Ira S. Bowen, director of Mount Wilson and Palomar Observatories, has announced that the 200-inch telescope might not be in working order until next fall. In figuring the mirror, a zone 18 inches wide at the edge was allowed to remain 20 millionths of an inch too high, and the support system has not been able to introduce the desired correction of the figure. In addition, the edge of the mirror has been found to respond to temperature changes more quickly than the center. It is expected to install a set of small fans and to insulate the mirror's outer edge with aluminum foil. Thereafter, if the supports are still unable to correct the raised zone, the mirror will have to be taken out of the telescope for refiguring—a matter of six months. **Time** states that Dr. Bowen pointed out that the 100-inch telescope on Mount Wilson did not work acceptably for a year and a half, and he is undiscouraged by this recent turn of events.

Sky and TELESCOPE

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A NEW FILM ON SOLAR PROMINENCES

McMATH-HULBERT Observatory of the University of Michigan has for years been famous for its work on observing the sun. In the early '30's it pioneered in applying motion-picture techniques to recording the continuous and fascinating changes in solar prominences. At gatherings of professional and amateur astronomers the McMath-Hulbert films have never failed to arouse great interest. Now the Audio-Visual Education Center of the University of Michigan (Ann Arbor, Mich.) announces that a new sound film entitled, "Solar Prominences," may be rented for $1.50 per day or purchased for $40.00. The film size is 16 millimeter.

Either the red light of the hydrogen-alpha line or violet light produced by ionized calcium atoms may be used in making motion pictures with the McMath-Hulbert spectroheliograph; in the film both kinds of pictures are shown. Five types of prominences are presented: quiescent, spot, cap, quasi-eruptive, and loop or fountain. As each frame of the film is on the average separated from the next by about one half of a minute, the motions of the sun's prominences are speeded up 720 times. The 11 minutes required for the film's projection represent about 140 hours of observation.

The script describes the action in the nine scenes of the film. As an example, Scene 7 is of large loop-type prominences, with the following dialogue:

"Unusual, but probably very significant prominence forms, are the loops, or fountains. The bright spot which appears at the top of each loop is a condensation, and from this small area material flows downward along both branches of the loop. The condensation seems to be an inexhaustible source, for it continues to supply material for many hours without much change in size or brightness. Loops always occur in a region near active sunspots. The sunspot associated with these loop-type prominences is exactly in the center of the arc representing the chromosphere and very near the edge of the sun. The region of the sun's surface directly over the spot is not outstandingly active, but the loop structures are noteworthy because of the size and the length of time that they are observable. Such disturbances ordinarily are visible only for an hour or two; the record presented here was photographed on four successive days."

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JANUARY, 1949

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BACK COVER: This drawing by Russell W. Porter shows the declination trunnion of the 200-inch Hale telescope, Palomar Observatory, California. Courtesy, California Institute of Technology. (See In Focus.)

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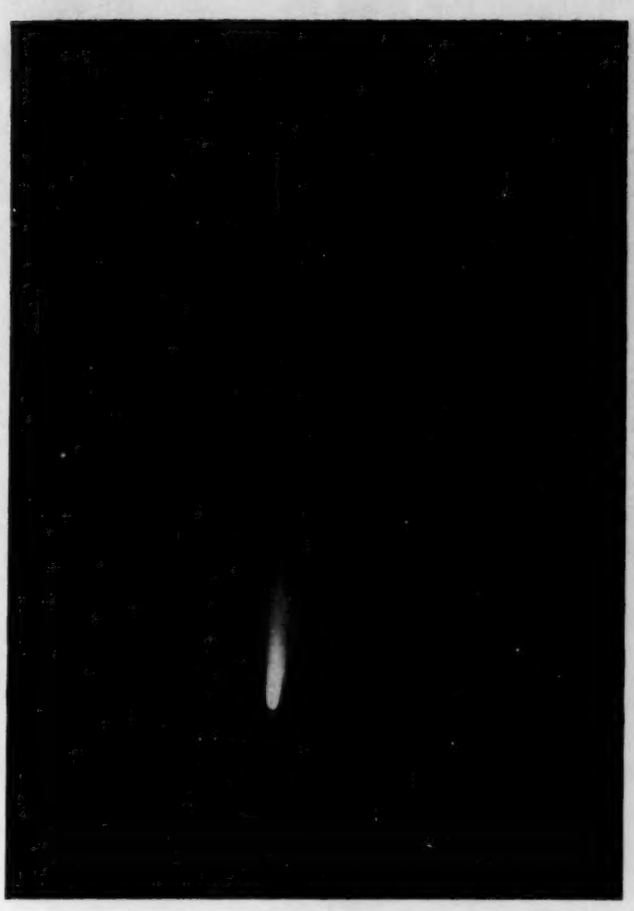


These two pictures of Comet 1948 l were taken on the same morning, November 13th, but as the one at the right was made at Harvard's South African station (by W. D. Victor), it shows the position and appearance of the comet a few hours earlier than does the picture above, which was taken at the Montevideo Observatory in Uruguay (by Esteban Rondanina). The 10-inch Metcalf triplet required an exposure of 37 minutes to make the Harvard photograph, while the camera used at Montevideo was so fast it recorded equally faint stars and as much of the comet's tail in only five minutes exposure. The star field is principally in Hydra; Beta Corvi is situated near the center left edge of the Montevideo picture, with two fainter stars to the right and above it.

The Eclipse Comet of 1948

BRITISH Astronomical Association Circular No. 303, dated November 10, 1948, under the title, "The Eclipse Comet, 1948 l," reads in part:

"There can be little doubt that the bright comet now reported seen in the southern morning sky is identical with the one seen during the eclipse of November 1. The *Times* of November 2 in the report of the eclipse from its correspondent at Nairobi stated that a bright comet, with a long tail, was seen both by the crew of an R.A.F. aircraft and by observers on the ground. The head, it was stated by one amateur astronomer, was still visible a few seconds after the Sun began to emerge.

"A cable received by Dr. R. d'E. Atkinson, leading the Royal Observatory expedition, reports photographic confirmation of it, saying it was 93′ from the centre of the Sun in position angle 226°, and was very bright, with a tail."

Harvard Announcement Card 956, dated November 22nd, reads in part:

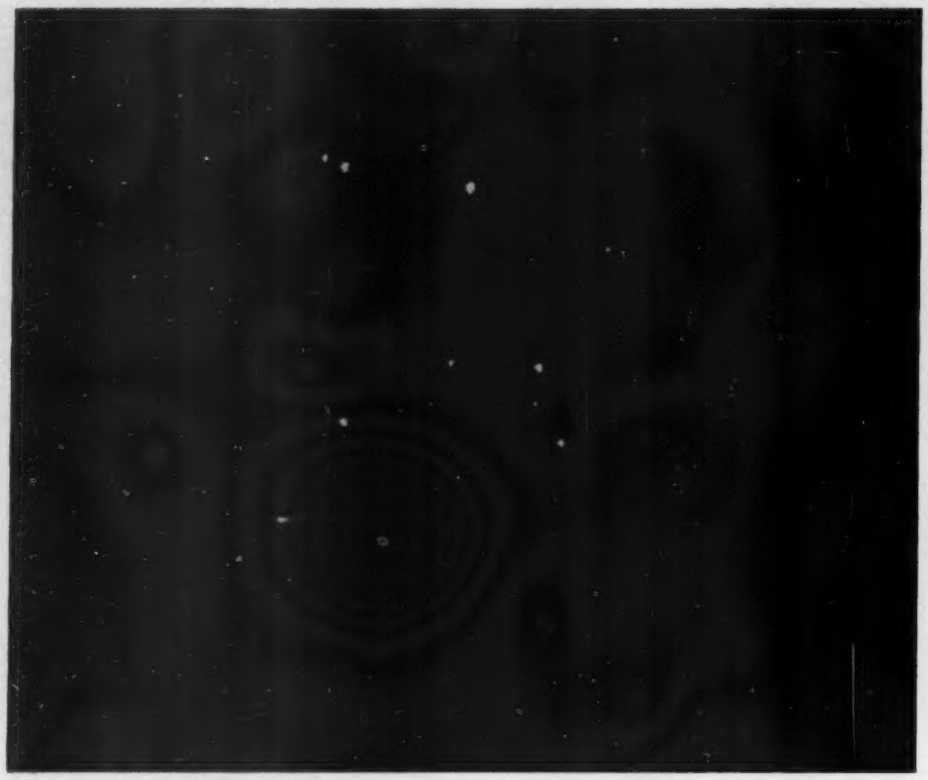
"Dr. Leland E. Cunningham, Students' Observatory, University of California, Berkeley, writes: 'New elements have been determined for the bright comet.... These place the comet in position angle 228° and 104′ distant from the sun at the time of the total eclipse on November 1, which are in moderate agreement with Atkinson's observed values of 226° and 93′, respectively.'"

Thus, although Comet 1948 l was missed by northern observers before it passed perihelion late in October, when its tail must have extended into the evening sky after sunset, the total eclipse of the sun provided a favorable opportunity to observe the comet practically a week before southern observers viewed it in their morning sky. It well can be called the "eclipse comet" of 1948.

Incidentally, the BAA circular also reports that Dr. Atkinson's eclipse expedition (*Sky and Telescope*, VIII, 37, December, 1948) carried out its observing program successfully.

Observers in the United States, chiefly in the south and west, were quite successful in viewing and photographing the comet. Space permits publication of only a few of the many photographs and reports which have been received.

HERE IS A REPORT of the independent discovery of a beautiful comet yesterday morning — if indeed one can call it a discovery when the object is so startlingly apparent at a glance. I am working here in northern Chile at the Smithsonian solar station, located



From the summit of Mt. Hamilton in California, members of the Palo Alto Astronomy and Telescope Club observed and photographed the comet daily starting November 11th. This picture, made on the 13th, shows the constellation of Corvus with the comet below it. Exposure was 15 minutes, f/2.9, Plus-X film.

in the heart of the Atacama Desert and nothing, I repeat, absolutely nothing, grows near here. Our elevation is 9,300 feet; our position 22° 37′ south, $4^h\ 35^m.3$ west.

At about 4:30 a.m. November 7th (yesterday) I got up to start heating some water on our kerosene stove, and also to look at the sky in order to see if we would be able to start our observations shortly after sunup. On going to our front door, which faces eastward, I saw a bright ray extending upward from behind the nearby hills. At first I thought it was a ray of sunlight shining through haze, but only a moment's consideration proved it to be a comet of 2nd or 3rd magnitude. My wife was awakened, and together we admired the sight for several minutes. By this time the nucleus had risen, and we had a fine view.

The only camera at hand was my Leica, which was loaded with Kodachrome. Nevertheless, we made a few pictures, just hoping. This morning we rose early, had the camera loaded with Plus-X film, and tried some exposures with that. The comet is farther ahead of the sun, and not so bright as yesterday.

We would have tried to get a cable sent to the Harvard Observatory, but it seems certain that the comet must have been discovered the previous morning by anyone in the Southern Hemisphere who happened to be looking east just before sunrise. Unfortunately, this comet may be too far south to be visible from the United States, much as was the case with the fine comet of December, 1947. We had an excellent view of that, too. It is a pity that we do not have a telescope of any description with which to examine *el cometa.* Our solar work is done mainly with a spectrobolometer — thus we are an observatory without a telescope.

The comet is more conspicuous even than a 1st-magnitude star, but that is due to the great area, which makes an estimation of magnitude very difficult. Its tail is at least 12 degrees in length, extending nearly straight into the sky as viewed from here, and fanning out to a width of 1½ degrees. Its approximate position is near 13 hours right ascension, 22 degrees south declination.

I used to belong to the National Capital Astronomers, and my wife is the daughter of U. Sherman Lyons, of the U. S. Naval Observatory. We expect to fly home soon, arriving in Washington on December 3rd, and I shall develop my photos then.

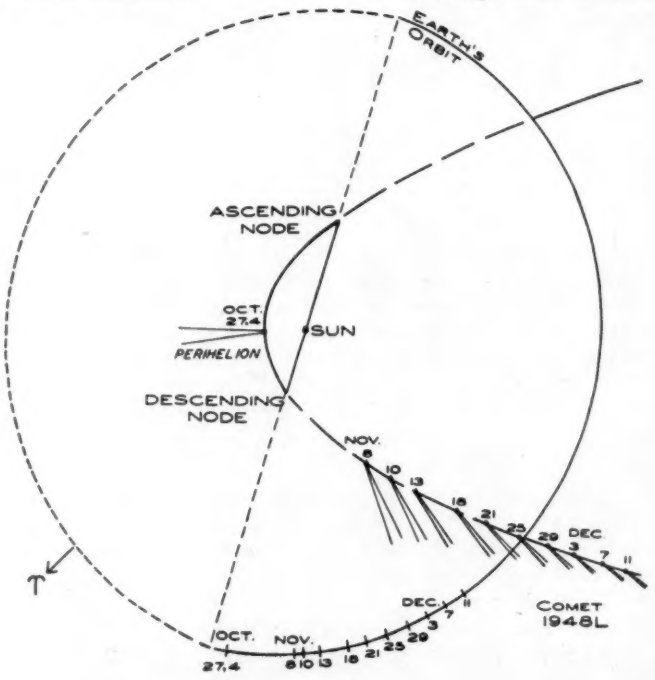
WILLIAM P. HARRIS
Mt. Montezuma, Chile

THE COMET was first reported by a pilot of an Australian National Airways passenger plane between Perth and Adelaide, at 3 a.m., November 8th. The comet was in the east southeast. At 5 a.m. that morning an aircraft flying from Sydney to Fiji also reported the comet. From Timaru, at 3:30 a.m., November 9th, amateur astronomer Jones reported a comet in position $13^h\ 30^m$, −20°. On both these mornings our local skies were overcast, but on Thursday morning, November 11th, I arose at 3 a.m. and observed quite a portion of the tail of the comet. Half an hour later the whole comet was visible, the tail maybe 30 degrees in length.

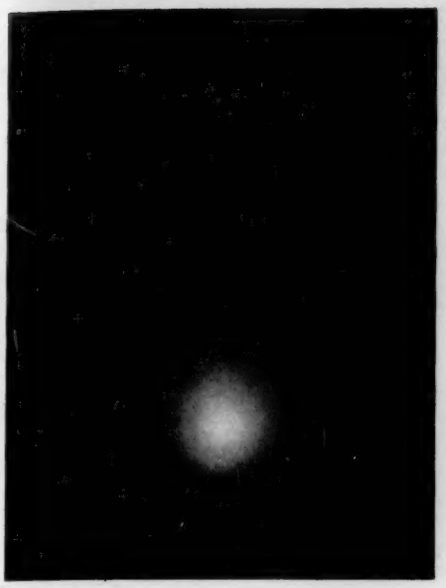
It was a good naked-eye object, and also good in binoculars. The nucleus was a fine sight through my 3-inch Dollond refractor, using a 60x eyepiece. This morning (November 12th) was overcast and no observations could be made.

On Thursday morning the comet was situated about one degree north of Spica. Instead of the slightly curving tail of last year's visitor, the new comet had a straight tail.

ROY V. SYMONDS
Hastings, New Zealand



In this diagram, the parabola representing the comet's orbit is in the plane of the paper. At perihelion, Comet 1948l was north of the ecliptic plane and the comet should have been seen by northern observers in the evening twilight. The nearest approach of the comet to the earth occurred about November 20th, at a distance of some 50 million miles. Drawing by Robert E. Cox.



On November 22nd, the 60-inch reflector of Harvard's southern station was used to photograph Comet 1948 l with a 7½-minute exposure. This reproduction is enlarged about two times from a negative which shows the tail to be composed of many narrow filaments. Photograph by J. S. Paraskevopoulos and M. J. Bester.

BUMPER COMET CROP IN 1948

For the second consecutive year a total of 14 comets has been reported. Of these celestial wanderers 12 are new objects and two are recoveries of previously observed comets. This year's comets are: 1948a, Mrkos; 1948b, Wirtanen (periodic); 1948c, Keuskamp; 1948d, Pajdusakova-Mrkos; 1948e, Periodic Comet Forbes 1929 II; 1948f, Periodic Comet Neujmin 1 (1913 III, 1931 I); 1948g, Honda-Bernasconi; 1948h, Wirtanen; 1948i, Ashbrook-Jackson (periodic, possibly identical with some lost periodic comet); 1948j, Johnson; 1948k, Wirtanen; 1948 l (see page 59); 1948m, Bester V; 1948n, Honda.

Comet 1948m (Bester's fifth in three years) was first sighted November 24th in right ascension $7^h\ 37^m$, declination −75°, of magnitude 7.5. During December it moved westward and northward through Reticulum, Horologium, Eridanus, and Fornax. It will probably be too faint to spot with ordinary telescopes when it comes within reach of north-temperate-zone observers. On October 21st, when the comet was at perihelion, it was 118 million miles from the sun. Its orbit is inclined 87° 45′.

Minoru Honda, at Kurashiki, Japan, spotted his third comet in a little over a year on December 5.8, a diffuse object of magnitude 9. It was at position $13^h\ 50^m$, −24° 20′ (within seven degrees of the first accurately given position of Comet 1948 l).

It was observed through early December at magnitude 10. An orbit by Dr. L. E. Cunningham gives perihelion passage on November 20th at about ½ A. U. He transmitted to Harvard an ephemeris for December, the predicted position on the 27th being $13^h\ 38^m.3$, −27° 14′, and added a note that the comet may have transited the sun on November 17th.

TERMINOLOGY TALKS.. J. Hugh Pruett

Abundance of Comets

The appearance of Comet 1948 l only 11 months after the Great Comet of 1947 means that no longer can persons of middle age and younger say they have never seen such an object "since none has been around during my lifetime." As the latest visitor was not easily observed from the northern United States and Canada, however, it is still true that for these regions there has been no spectacular comet since the return of Halley's in 1910.

Many persons who have not seen what ancient accounts sometimes referred to as "hairy stars" could have spotted one or more small ones during the past few years had they known just where to look. Early in 1943, when Whipple's faint comet was in the northern sky for many weeks, a druggist asked me, "Isn't there a little comet or something traveling close to the Big Dipper?" He had accidentally spied the suspicious-looking object without optical aid, then turned his binoculars on it to note the wide nebulous head. No tail was visible as it was then directly behind the head and pointing away from us, since we were between the comet and the sun.

Every year many small comets are visible with telescopic aid; the faintest comets require powerful instruments. A record was made in 1932 when 13 comets appeared, but this was bettered in 1947 with a grand total of 14. The year just closed had equaled this total by December 6th (see note at left).

Naming of Comets

Many comets have after discovery carried the names of their discoverers. Sometimes two observers independently locate such an object, and thereafter it bears a double name. In other cases, the name is that of the scientist who has done considerable work on the orbit, as with Halley's and Encke's comets. Others go only under a numerical designation such as the year of discovery with a letter or Roman numeral attached. In recent years the latter nomenclature is applied even though the comet also carries its discoverer's name. In fact, two such numerical names are given each comet.

Let us illustrate. Suppose that a comet is the fourth to be discovered (observed) in 1950. It will then be labeled 1950d. But if it becomes the third comet that year to reach perihelion, it will also go under the more permanent designation 1950 III. Some comets reach perihelion the year before or after their discovery, so they have two years in the two types of naming.

Coma, Nucleus, Tail

A well-developed comet is made up of a head and a tail. The head in turn is composed of a coma and a nucleus. The coma comprises the great volume of the fuzzy head, and is composed of dust and gases. In some very large comets the diameter of the measurable coma has been one million miles, or greater than that of the sun. The coma usually diminishes in apparent size as the sun is neared.

At the center of the coma a bright, starlike nucleus sometimes becomes quite conspicuous as the comet approaches the sun, but in many cases there is no such central condensation in evidence. The nucleus may appear as luminous as very bright stars, and it is for the nucleus that a comet's position is usually given. In addition to dust and gases, the nucleus consists of a great number of small, solid particles — it is akin to a swarm of meteorites with considerable space between the individual particles. This part of a comet may be a few thousand miles in diameter.

Cometary tails are the really impressive parts of these strange visitors from the vast planetary spaces. Sometimes straight and at other times curved like a scimitar, they occasionally span great stretches of the heavens. The tail of Halley's comet in 1910 was discernible to some observers over an arc considerably greater than the angular distance from the horizon to the zenith. The Great Comet of 1843 had a visible tail actually about 200 million miles long. The tail is missing or inconspicuous when a comet is at a considerable distance from the sun, but it grows as the sun is approached.

A comet's tail points away from the sun. When the comet is approaching our central luminary in preparation for the grand perihelion swing around it, the tail follows the head; when receding, the tail leads the way. Comets' tails are thought to be formed of molecules and atoms pushed away from the head by the radiation pressure of sunlight. When very small particles are concerned, the solar light pressure is greater than the gravitational attraction toward the sun. Cometary tails are little more than "such stuff as dreams are made of," mere sprays of rarefied material with very little actual mass. They are evidently quite harmless, for it is fairly well established that we passed through just such cosmic mist in both 1861 and 1910.

The material forming the tail is lost forever to the comet. A comet that visits the solar region too often should in time become considerably depleted. Halley's comet must have started quite amply supplied to last as long as it has with so many known returns, but there is evidence that it has decreased in brightness by about two magnitudes in a thousand years.

NEWS NOTES

By Dorrit Hoffleit

RAS MEDAL TO LINDBLAD

The Gold Medal of the Royal Astronomical Society has been awarded to Professor Bertil Lindblad, director of the Stockholm Observatory and president of the International Astronomical Union. In awarding the medal, Professor W. M. H. Greaves, president of the society, commented that the recipient of the greatest honor the society could bestow is both a practical astronomer and a theoretician who tackles problems that are not only astronomically important but intrinsically difficult.

Dr. Lindblad has made notable contributions in the fields of stellar luminosities, the rotation of the galaxy, and the dynamics of stellar systems. The last was the topic of his address on the occasion of receiving the medal—paraphrasing the title: how the spiral nebulae got that way. He began by working out the conditions for the stability of circular orbits near the edge of a highly flattened rotating system of stars and showed that instability will occur if the flattening is large enough. When such instability develops, the orbits will not remain circular and the system will break up by equatorial loss of matter. The development of spiral arms is explained and theoretical results compared with observed spirals.

In the case of M81, the well-known galaxy in Ursa Major, Dr. Lindblad suggests that the present spiral structure should have developed during somewhat less than two whole revolutions of the system. For M33, the open spiral in Triangulum, observation seems "to confirm in a general way the theoretical demand that the rotation occurs in the direction of winding of the spiral arms when these are followed from the centre outwards. From the observed velocities and the present angular distances between the branches we conclude that the age of the present spiral structure is comparable with the time of revolution of the nebula, of the order of 10^8 years."

In closing his paper, Dr. Lindblad said: "The fairly rapid development of the spiral structure, once it has begun to form, which we have found by comparison between theory and observation for certain objects may seem surprising. It may mean, however, that the development of spiral structure is not strictly a one-way process for one and the same system. It seems probable that the process is quasi-periodic, repeating itself perhaps with certain intermediate periods of rest, during a certain era of the development of the system.

"The ultimate cause of the development of spiral structure is no doubt the formation of stars and dust particles out of a primitive gaseous system. This increases the effective degree of flattening towards the plane of rotation, and makes the system unstable against the Riemann wave and the density wave of the 'bar.' These waves break up the system, as we have seen, either in a 'normal' or in a 'barred' spiral structure.

"In this way the theory of the dynamics of the spiral structure gets an important position in the general theory of cosmical evolution. The theory of the constitution and dynamics of stellar systems, when it once gets a sufficient clarity, as without doubt it can, will form a kind of frame into which the theories of the formation of the elements, and of the generation of the stars, will have to fit. . . ."

COMING: 180 DAYS TO A YEAR

A few billion years from now a year will have only 180 days, Science Service quotes Dr. G. M. Clemence, director of the U. S. Nautical Almanac Office. Tidal friction causes the earth to rotate a tiny bit slower each year and eventually the day will be twice as long as now. Then the length of seconds pendulums will have to be increased from 39 to 55 inches.

THE OZONE SHADOW

The triatomic molecule, ozone, forms layers in the earth's atmosphere which absorb sunlight and starlight of wave lengths shorter than about 3000 angstroms. R. Penndorf, Watson Laboratories, Air Materiel Command, writing in the *Journal of Meteorology* for August, 1948, discusses three methods of measuring the vertical distribution of ozone. Each is based on the fact that for ultraviolet radiation the radius of the earth's shadow is enlarged by an amount equal to the altitude of the uppermost effective boundary of the ozone, which is about 50 kilometers high.

The ozone shadow causes a delay in the ionization of the radio-reflecting E layer each morning as the sun rises. The first rays to reach the E layer at the zenith still pass through the ozone — its shadow cuts out the ultraviolet until the sun has risen sufficiently for rays tangent to the top of the ozone to reach the E layer directly. At that moment short-wave radio apparatus records an abrupt increase in the ionization of the E layer, but the delay after sunrise can be nearly 30 minutes in latitude 50° near the time of the summer solstice. At latitude 20°, the delay is only 10 to 14 minutes throughout the year, corresponding to the short tropical twilight.

In March, 1942, French astronomers D. Barbier, D. Chalonge, and E. Vigroux made studies of an eclipse of the moon. From lunar spectra in the visible region, they determined ozone masses in eight different ray paths, for sunlight that on its way to the moon had approached the earth's surface within four to 17 kilometers, and therefore had gone through the ozone layers. The maximum ozone content seemed to be at a height of about 12 kilometers.

A third way of observing the effect of the ozone shadow is by means of the sodium D line in the spectrum of the evening sky. In 1938, R. Bernard observed that within 10 minutes after sunset the intensities of the sodium D lines dropped suddenly to one per cent of their former values, and remained constant thereafter. In this case also, the delay is a phenomenon of the ozone shadow, and observations indicate that the D lines are produced in a layer about 100 kilometers high on the average. The fact that the sodium continues to emit light after sunlight has been cut off is attributed to excitation of the atoms by collision processes.

METEOR CRATER IS SQUARE

In the Contributions of the Meteoritical Society in the November issue of *Popular Astronomy,* Walter W. Zimmerman discusses aerial photographs he made of the famous Canyon Diablo Crater. The photographs obtained at several different times of the year from altitudes between 13,000 and 14,700 feet at positions nearly vertical above the crater indicate that the crater is not approximately circular or oval as commonly supposed. It might more properly be described as nearly square with rounded corners. The east and west rims are quite straight, and to a lesser extent also the north and south rims. Here is something more to be explained.

NOBEL PRIZE

Professor P. M. S. Blackett, of Manchester University, was awarded the Nobel prize in physics for 1948 for his work in cosmic radiation. While he was at Cavendish Laboratory (Cambridge University) he discovered positrons in cosmic ray showers and succeeded in producing positrons artificially. In 1933, he estimated that these short-lived particles are really so abundant that they may account for 1/1,000 of the material in the universe. Professor Blackett is best known among astronomers for his recent work in reviving and revising theories connecting the rotations of the sun, earth, and stars with their magnetic fields. In particular, he pointed out the constancy of the relation between the angular momentum of a rotating body and the axial component of the dipole magnetic moment. That these fields may indicate a new fundamental property of rotating matter, as suggested by the Nobel prize winner, has yet to be proved. S. Chapman has currently shown that the magnetic fields of sunspots cannot have this fundamental character, and must be explained by some different mechanism.

A Calendar for 4,000 Years

By Edward T. Krach

MOST so-called perpetual calendars used for finding the day of the week cover only a few hundred years and make use of various keys and factors. They are usually not available when needed. The method described here requires only pencil and paper. As we build it up gradually, we shall gain understanding of why it is bound to be accurate. With this understanding it is easily remembered for use when it is needed.

There are two kinds of years — ordinary and leap — of 365 and 366 days. They are, respectively, one day and two days in excess of even weeks, as may be found by dividing each by seven. You have no doubt noticed that as a result of this fact a particular date in any year falls one day later in succeeding ordinary years and two days later in a succeeding leap year. For instance:

October 5, 1947—Sunday
October 5, 1948—Tuesday
October 5, 1949—Wednesday

Notice the one-day jump in 1949, an ordinary year, and the two-day jump in 1948, a leap year. This extra day occurs, of course, on February 29th.

Why not use this single fact as the basis for a calendar, combined with the common knowledge that January has 31 days, February 28 days (29 in leap year), March 31, April 30, May 31, June 30, July 31, August 31, September 30, October 31, November 30, December 31. To save time computing dates during the year, note that the first three quarters contain, respectively, 90, 91, and 92 days.

For the days of the week, we shall designate Sunday as 1, Monday as 2, Tuesday 3, Wednesday 4, Thursday 5, Friday 6, and Saturday as 7 or 0.

As an example, let us start with a date prior to 1752; in that year an important change occurred in the calendar which will be explained later. From Ridpath's *History of the World* we have, "the next day being the Sabbath, was spent in religious devotion, and on Monday, the 11th of December 1620 the Pilgrim Fathers landed on the Rock of Plymouth."

1620	1620 jumps since the beginning of year 1 A. D.
405	Every fourth year was a leap year up to 1752. We get this 405 by dividing 1620 by four. Because there is no remainder, 1620 was a leap year. If there were a remainder it would be ignored.
90	Here we compute the jumps in
91	the year 1620. The first three
92	quarters take us up to October.
31	Add 31 for October, 30 for No-
30	vember, and 11 to December
11	11th. Notice that in the first quarter we always use 28 days for February, because the 405 took care of the extra jump in 1620 as a leap year.
2370	Total jumps, January 1, year 1 to December 11, 1620.

We must now examine our starting point, January 1, 1 A.D. The *Encyclopaedia Britannica* says this day was a Saturday, which would give us two jumps to start with instead of zero. To counteract it we must use a fixed "minus 2" in all calculations prior to 1752. Our total is now 2368. Dividing this by seven leaves a remainder of two, which is Monday.

The next example is from the article on Columbus in the *Encyclopaedia Britannica*: "and at two in the morning of Friday October 12, 1492 a sailor aboard the 'Nina' announced the appearance of what proved to be the New World." In skeleton form, as you would compute it, this date is:

1492	
373	
90	
91	
92	
12	
2	minus
2148	
306 + 6	Friday

Because of the fact that the Julian method of applying leap years to the calendar does not well account for the true length of the tropical year, a correction was necessary in the calendar. Pope Gregory decreed changes in 1582 which were not adopted in the British Empire until 1752, when Thursday, September 14th, was made to follow Wednesday, September 2nd, in that year. The leap-year rule was changed, in that century years unless divisible by 400 were not leap years. Therefore, a slight change is necessary in our calculation for dates subsequent to September 14, 1752, or for any dates based on the Gregorian calendar system.

In Lossing's *History of the Civil War* we read, "and on Wednesday, the 12th of April 1865 they laid down their arms." Thus, we compute:

1865	
466	Leap years considered as every fourth year.
18 minus	This is minus since the 18 century years to 1865 were not all leap years.
4	But four of them were: 400, 800, 1200, and 1600. Note that the 18 minus and the 4 plus are always evident in the numbers above, 1865 and 466.
90	First quarter of 1865
12	Days to April 12th
2419	Now divide by seven
345 + 4	Wednesday

What has become of the minus 2 used before 1752? We still need it and two new corrections. But notice what becomes of them. When we eliminated 18 century years according to the new calendar, 13 of them were actually leap years under the old calendar. The 11

(Continued on page 78)

WHIRLPOOLS AROUND BINARIES

The lecture given by Dr. Otto Struve, of Yerkes Observatory, when he received the Bruce gold medal for 1948 from the Astronomical Society of the Pacific is discussed by Dr. A. Hunter, Greenwich Observatory, in the British publication, *Science Progress,* for October, 1948. An adaptation of Dr. Struve's lecture appears in the June, 1948, issue of the *Publications* of the Astronomical Society of the Pacific, and opens with these words:

"If someone should tell you that the elongated, elliptical orbits of the components of very close double stars are oriented in such a way that they all seem to point in the direction of the earth, you would probably call the idea preposterous and attribute it to idle speculation."

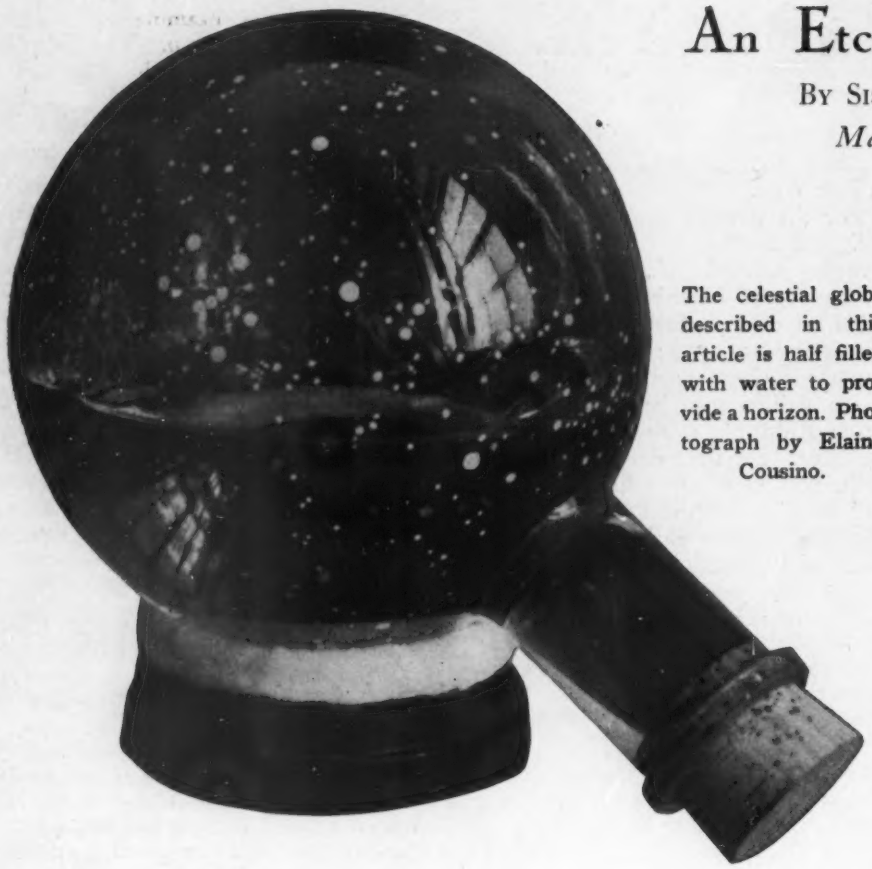
In 1908 a Canadian amateur astronomer, J. Miller Barr, published a paper concerning the orbits of 30 spectroscopic binaries for which he found a definite tendency for periastron to be located at or near the most distant point of each orbit as measured from the earth. Work by many astronomers since that time, including Dr. Struve himself, has verified this peculiarity, with some modifications. So the Yerkes astronomer has looked for a less geocentric and therefore more probable interpretation of the observations.

The first clue came when astronomers found that U Cephei, an eclipsing binary known by its changes in light to have a practically circular orbit, appeared spectroscopically to have an orbit of high eccentricity. Dr. Struve came to the conclusion that a stream of gas must envelop the double-star system and always move in the same direction as the binary components. The gaseous stream often exceeds but rarely falls behind the stars in angular velocity. This causes apparently asymmetric spectral lines and spurious excesses in measured Doppler shifts. This picture, in its important details, disposed of the unreasonable previous inferences. Dr. Hunter summarized the achievement with a comment to the effect:

"The camera cannot lie . . . , but in astronomy the indications it affords have to be looked at very, very carefully if the unwary observer is not to be deceived."

An Etched Celestial Globe

By Sister M. Ignatia, I. H. M.
Marygrove College, Detroit



The celestial globe described in this article is half filled with water to provide a horizon. Photograph by Elaine Cousino.

A MODEL of the celestial sphere on which the positions of the stars are represented without distortion is an invaluable aid in teaching astronomy. Celestial globes, however, are frequently very small, often only six or eight inches in diameter, and opaque globes necessitate our viewing the stars from a point outside the sphere.

In 1934, Gaylord Johnson published directions for painting constellations and significant circles on a transparent round-bottom flask and showed how the resulting sky globe, or parlor planetarium, could be used to demonstrate many astronomical phenomena.[1] If the desired marks are etched into the glass with hydrofluoric acid instead of being painted on, the result of careful work is a celestial globe of great beauty and accuracy, a globe suitable not only for parlor tricks, but for demonstration use in astronomy classes as well. The etching procedure given below was worked out by Lawrence H. Thomas, of Dearborn, Mich., as he and his daughter Anne prepared a globe for the class in descriptive astronomy at Marygrove College.

A three-liter, eight-inch-diameter, pyrex glass flask with short neck and round bottom was half filled with hot water, and securely corked. The flask was placed in various positions upon a cake of beeswax and rotated until the entire outer part was covered with a thin, even coat of the wax. Thereafter, every mark which removed a bit of the wax was permanently etched into the glass when it was exposed to hydrofluoric acid.

The point on the bottom of the flask, diametrically opposite the exact center of the neck, was the first to be marked. This point represented the north celestial pole, and was used as the position of the fixed tip of the beam compass which drew the great circle of the celestial equator and eight parallels of declination at 10-degree intervals between the equator and the north pole. Because of the neck of the flask, only seven of these smaller circles could be placed south of the equator, and the south celestial pole could not be indicated.

At 23½ degrees from the north celestial pole, a small cross designated the north pole of the ecliptic. Then the ecliptic and 24 hour circles, 15 degrees apart, were drawn in the wax with the beam compass. When the hour circles and the parallels of declination were numbered, tiny circles drawn to a magnitude scale were used to mark the positions of the important stars as they are shown on a globe — reversed in position from east to west. Note the relative positions of Orion, Sirius, and Procyon in the picture of the globe. Finally, the connecting lines for the constellations were dotted in, and after the hydrofluoric acid had etched the marks permanently into the glass, white lacquer was used to fill in the circles which represented the stars.

When the outside of the flask was finished, the inside was cleaned with concentrated nitric acid until water droplets no longer clung to it. Then the flask was filled exactly half full with distilled water to which three drops of blue-black ink were added to give the effect of ocean water. A tiny three-masted schooner was floated on the surface of the water (left side of picture).

To support the flask we chose a wooden ring of the type used in chemistry laboratories for round-bottom flasks, and carefully padded the edges. We found a cork of such length that when the corked flask was placed on the support with the cork touching the table, the altitude of Polaris equaled our own latitude. Then we imagined ourselves on the tiny schooner and rotated the flask by turning its neck. Looking out through the globe we saw Cassiopeia and Ursa Major go around Polaris without dropping below the horizon, represented by the water level. We saw Orion, Cancer, Bootes, Lyra, Pegasus, Andromeda, and their neighboring constellations rise, march across the sky, and drop below the horizon. Mentally leaving the little ship, we noted that as long as the cork touched the table, Centaurus and Crux did not come above the water.

Such a globe is exceptionally valuable in drilling recognition of the important stars and constellations, and in reproducing the apparent movement of the stars as seen from any latitude. If the flask is adjusted on its support so that the neck is horizontal, we can demonstrate the fact that all the stars, as seen from the equator, rise and set. When the neck of the flask points directly upward, the stars appear to move as they would to an observer at the South Pole. There, all visible stars are circumpolar: none rise and none set, but only half the stars of the celestial globe are above the water level. The other half would be similarly visible from the North Pole, tracing perfect circles around the sky and never dropping below the horizon. The globe can be used to drive home the fact that "the latitude of a place equals the altitude of the celestial pole at that place."

To demonstrate the relative motion of the earth and the sky, the little ship can be replaced, imaginatively or actually, by a small glass sphere in the exact center of the globe. If actual replacement is desired, the small sphere can be blown at one end of a piece of glass tubing and the other end inserted in the cork which closes the neck of the flask. This method is used in some of the simpler globes made from round-bottom flasks, for instance, those upon which only the celestial equator, the ecliptic,

(Continued on page 75)

[1] Johnson, Gaylord. "Homemade Planetarium for Amateur Astronomer." **Popular Science Monthly**, 125 (November, 1934), 46-47.

Amateur Astronomers

Four Well-known Amateurs Die

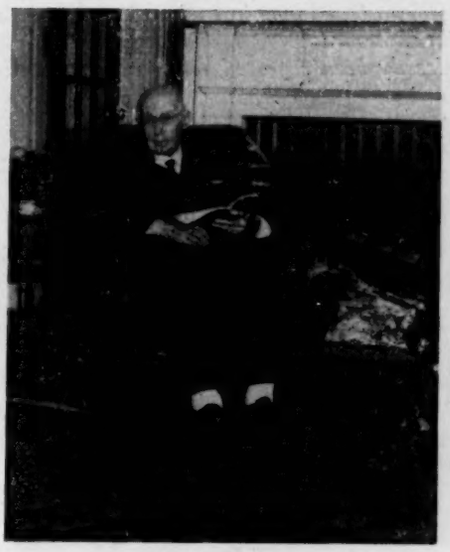
RECENTLY, reports have been received of the deaths of four amateur astronomers who had contributed much to the science of astronomy and who were widely recognized as leaders in their fields. In mid-August, the Reverend William M. Kearons, of West Bridgewater, Mass., died suddenly at his summer home. On October 24, 1948, the Reverend T. C. H. Bouton, of St. Petersburg, Fla., died just a week before he would have attained 92 years of age. Somewhat later, Frank I. Noyes, of Cambridge, Mass., passed away suddenly, and on November 18th, at the age of 81, Charles A. Lower, of San Diego, Calif., succumbed after a long illness.

Readers of *Sky and Telescope* have often seen reproductions of sunspot photographs taken by Mr. Kearons, who maintained for many years a steady series of visual and photographic observations of the sun. Whenever an unusual spot group would appear, or the sun would present extraordinary spottedness (or lack of spots) he would submit pictures taken with the equipment he kept continually in use. The solar observer is survived by his wife, who assisted Mr. Kearons in his photography, made sunspot drawings for the solar division of the AAVSO, and kept the records of their combined observations. She is a regular observer of variable stars.

The AAVSO lost its senior observer in the Reverend Mr. Bouton; in 1911 he was one of the first to join the ranks of the society as an active observer. He received the second merit award of the association in 1936. As a retired clergyman, Mr. Bouton lived in St. Petersburg, Fla., for the past quarter of a century, where his observatory housed a 7-inch refractor. Until he was 90, he carried on an almost uninterrupted observing program on variable stars, and thereafter continued to entertain many visitors with views of celestial objects.

Mr. Noyes had long been identified with optical research, during the war years serving with the Harvard Observatory Optical Project as machinist and machine designer under Dr. James G. Baker. He had started his telescope making work strictly as an amateur, for he was a graduate of Harvard Divinity School and he held pastorates for a number of years. Later he joined the Massachusetts Registry of Motor Vehicles, and in the period before his death (at the age of 51) he acted as a lecturer on highway safety. For two years Mr. Noyes was president of the Amateur Telescope Makers of Boston.

The death of Charles A. Lower followed that of his son by only 15 months, thus closing the activities of a team that had pioneered in telescope making and astronomical photography by amateurs (see *Sky and Telescope,* November, 1947, page 11). Mr. Lower was born in Indiana, where he was a civil and mechanical engineer. Later he went to Oregon, and then to San Diego in 1917.



T. C. H. Bouton, at 90 years of age. Photograph by Lorne D. Beggs.

AMATEUR ACTIVITIES

The newly formed **Greensboro** (N. C.) **Astronomy Club** completed its organization in November, with 35 members. Officers include Mrs. Edith Settan, president, and Miss Sidney Holmes, secretary. Meetings are held on the first Thursday of each month, in the science building at the Woman's College of the University of North Carolina, in Greensboro.

The first lecturer before the new group was Miss Cornelia Strong, retired professor of mathematics, who spoke on the history and names of the zodiacal constellations.

Among the club's objectives is "to be, in every way possible, influential in getting a 40-inch telescope and observatory for the state-owned Woman's College." The group has voted to join the Astronomical League, and to take **Sky and Telescope** for all its members.

The **Darling Astronomy Club,** of Duluth, Minn., has adopted a new system whereby the first meeting of the month is for business, of which one feature is an astronomical discussion led by a member, and the second is devoted entirely to observation.

New officers are Frank A. Halstead, president; William B. Erickson, vice-president; Robert H. Schmidt, secretary-treasurer.

Public nights at the **Warner and Swasey Observatory** on January 6th and 7th will include a lecture on "Suns Which Vary in Brightness." Reservations may be had through the Case Institute of Technology, East Cleveland, Ohio, Tyler 1-1000.

The **Columbus Astronomical Society** has elected its officers for the year 1948-49 as follows: president, Kenneth Walker; vice-president, Dr. M. Hajos; secretary-treasurer, Miss Josephine Walcut; program, L. R. Tewart; observation, Clyde Eide; librarian, Miss Arden L. Seeger; membership, Frank A. Paullus and Meredith P. Gilpatrick.

THIS MONTH'S MEETINGS

Chicago, Ill.: The Burnham Astronomical Society will meet on January 11th at 8 o'clock in the Chicago Academy of Sciences auditorium. There will be installation of the 1949 officers and directors, an astronomical symposium of three 10-minute talks by members, and a social hour.

Cleveland, Ohio: On January 14th at 8:00 p.m., John Streeter, of Vassar College Observatory, will speak on "Early American History of Astronomy" at the Cleveland Astronomical Society meeting in the Warner and Swasey Observatory.

Geneva, Ill.: "Meteors and Meteorites" will be discussed by William Siekman at the January 4th meeting of the Fox Valley Astronomical Society, at 8 p.m. in the Geneva City Hall.

Indianapolis, Ind.: The Indiana Astronomical Society meets on January 2nd at Cropsey Hall, 2:15 p.m., when Paul Richey will speak on "Skylines for 1949."

Madison, Wis.: At the January 12th meeting of the Madison Astronomical Society, held at the Washburn Observatory at 8 o'clock, "Gaseous Nebulae" will be the subject of discussion by L. W. Ketchum.

New Haven, Conn.: The 12th anniversary meeting of the New Haven Amateur Astronomical Society is scheduled for January 22nd. Dinner at the Faculty Club will be followed by an address by Dr. Dirk Brouwer, of Yale Observatory, on "Astronomy in South Africa."

New York, N. Y.: Dr. Irving Kaplan, of Brookhaven National Laboratory, will speak on "Atomic Energy — in the Sun and on the Earth," at the January 5th meeting of the Amateur Astronomers Association, at 8 o'clock in the American Museum of Natural History.

Pittsburgh, Pa.: On January 14th the Amateur Astronomers Association of Pittsburgh will meet in the lecture hall of the Buhl Planetarium to hear Dr. Henry S. Leighton, of the University of Pittsburgh, lecture on "The Geology of Pittsburgh."

Stamford, Conn.: "The Coating of Optical Surfaces" will be discussed by Dr. Walter A. Fraser, of the Perkin-Elmer Corporation, at the January 21st meeting of the Stamford Amateur Astronomers, 8 o'clock in the Stamford Museum.

Washington, D. C.: Dr. Charlotte M. Sitterly, of the National Bureau of Standards, will lecture at the monthly meeting of the National Capital Astronomers on Saturday, January 8th, at 8:15 p.m., in the Commerce Department auditorium. Her subject will be "International Astronomy."

Trail Blazing with Spitz Planetariums

These accounts of the construction and operation of four Spitz planetarium installations reveal a new and significant chapter in the general story of astronomical education. Various ingenious means of providing the projection surface have been developed according to local circumstances and purposes. The use of an otherwise unoccupied observatory dome has already been reported by the Eastern Mennonite College at Harrisonburg, Va.

THE CONSTRUCTION of a planetarium dome at the Stamford (Conn.) Museum was, in every sense of the word, a unique project. Like many small institutions, we operate on a very limited budget. To have an outsider come in and build the dome was not financially possible. After we had consulted several engineers and construction people, it was decided, contrary to their suggestions, to use plywood ribbing. It was their belief that the plywood would not be sufficiently strong to support an 18-foot dome; nevertheless, we decided to make the attempt.

A local boat builder donated ¼-inch plywood, 14 feet long, in two-inch strips. The dome, which is 18 feet in diameter, has 24 ribs. Two pieces of plywood make up the circumference, and there are two 12-inch disks at the top where the ribs are joined. All ribs and pieces were bolted together with ¼-inch roundhead stove bolts. Certain ribs were reinforced with a triangular piece of plywood at the circumference, to keep the ribs at right angles and to provide places to fasten the sash cords which support the dome.

With the ribbing completed, several experiments were conducted in order to determine what material would be most suitable for the covering. A nylon parachute proved to be of little value, since its shape did not conform with that of a perfect hemisphere. Other materials, such as muslin, were considered, but these would have required a great deal of tailoring and careful fitting. Finally, corrugated cardboard proved to be the answer. This may be purchased in large rolls of any width. We first cut a pattern the exact shape to fit between two ribs, and then cut all the sections. These were stapled to the plywood ribbing with a stapling machine. Corrugated cardboard has sufficient stiffness so that all sags are eliminated. Its application to the ribs was not accomplished without much preliminary thought and the erection of scaffolding. It required a 24-foot plank erected over the dome so that a man could staple the cardboard to the upper part of the ribs, since the dome is not strong enough to support a man.

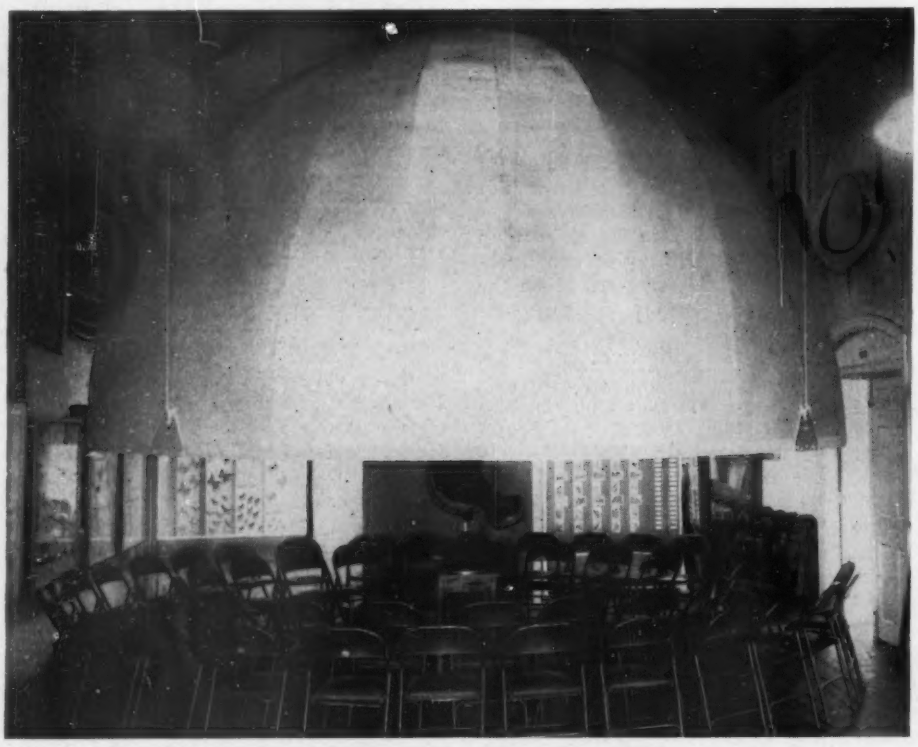
The problem here at our museum was to construct a dome that could be lowered and raised with ease so that the auditorium could be used for other purposes. The room is 35 feet high; therefore raising the dome to the ceiling puts it completely out of the way. The dome weighs 100 pounds. We fastened eight pulleys to the ceiling, ran eight sash cords through them, tying one end of each cord to the bottom of the dome. Counterbalances of sash weights of sufficient size make it possible to raise and lower the dome by moving an extra sash weight attached to a cord running to the center top of the dome.

We discovered that when paint was applied to the outer and inner surfaces of the dome the entire balance between the sash weights and the dome was affected by the weight of the paint applied, thus proving that the dome is perfectly suspended and that no part of it is affected by strain. The inside is painted a flat white, which gives excellent star images, and the outside is an aluminum color giving the appearance of metal construction.

The plywood ribbing in no way interferes with the star images. When it is in use, the dome is lowered to approximately five feet, eight inches, from the floor. No supports are required to keep it in place, thus eliminating any obstructing posts.

For a professional touch, a skyline cut out of black cardboard was placed around the horizon. It required exactly seven days of work to complete this dome with the help of three staff members and two trade-school boys.

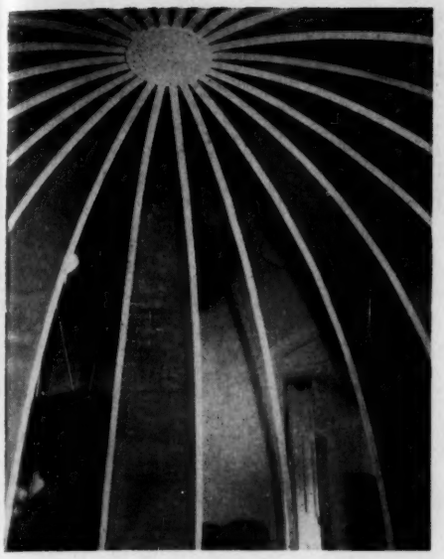
ERNEST T. LUDHE, director
The Stamford Museum
Stamford, Conn.



In the Stamford Museum, the planetarium dome is suspended by sash cords which run through pulleys in the ceiling. Note the museum exhibits on the walls of the multi-purpose room that may be darkened completely during a planetarium demonstration. Stamford Museum photos by SEAF Photo Service.

THE DAVIS PLANETARIUM at the Maryland Academy of Sciences is off our main exhibit hall, which is on the third floor of the Enoch Pratt Free Library (Baltimore's public library). The dome is 25 feet in diameter and the room comfortably seats 40 people. The dome is made of sheet aluminum and is constructed in the form of a 12-sided figure in four tiers, bolted together and painted white. We would prefer to have an absolutely hemispherical dome, but we cannot use wood here because of fire regulations. As far as star projection goes, our dome is perfectly all right, but with the meridian and co-ordinate projectors, and when twilight effects are used, a hemispherical dome would have been somewhat better.

We have found that a silhouette of the horizon (either the real one or an



The dome of the Stamford Museum under construction, showing several sections of cardboard in place.

imaginary one) adds greatly to the appearance of the planetarium room. Our horizon is separated from the dome by about two inches, so that the glow lights for twilight and dawn effects may be behind the silhouette.

Projection of the planets has been changed from that provided by the original Spitz instrument. Instead of the planet rings, we have placed around the drum a strip of black paper in which have been punched holes for the sun, moon, and planets. One strip is made for each week, but a hole for the moon is punched for every day, black tape being placed over the moon's disk except for the day in question.

Regular demonstrations in the Davis Planetarium are given at 4 p.m. on Monday, Wednesday, and Friday, and three on Thursday evening at 8, 8:45, and 9:30 p.m. This is the night of our regular weekly Maryland Academy of Sciences program, and the night when our observatory is open to the public. While only these six demonstrations are scheduled each week, about 20 in all are given on the average, the rest being classes from the schools by special appointment. Each demonstration lasts 30 to 40 minutes. No charge is made either to classes or individuals. On Thursday evenings, however, tokens are given out on request, because the demand is so great. So far the undersigned gives all the lectures, but if the demand keeps increasing an additional lecturer will have to be trained to fill in. But it seems difficult to find a person who knows the subject, knows the constellations, and can speak well too.

As our institution is not a school or college but a museum where people come only voluntarily, we definitely attempt the "show" type of presentation. Each month the demonstration changes, and we use auxiliary slides and motion-picture projectors whenever possible. Since our opening the subjects have been:

September ..... The Harvest Moon
October ..... Blinking Stars
November .. The November Meteors
December ..... The Christmas Star
January ..... Beneath Tropic Skies

As the visitors enter the planetarium, each is given a pamphlet describing the lecture. I gradually dim the dome lights as I give my introductory talk; when the room is pitch dark I sit by the instrument and turn on the stars. We get the usual exclamations as in the big planetariums. A feature of all demonstrations is a description of the stars seen that evening just after dark. Thereafter, there follows discussion of the current subject; for instance, in the December lecture we present the possibilities of comet, nova, and the "star" itself by means of a 2-by-2 slide projector connected with a rheostat. To conclude, a brilliant dawn is provided by lights placed below the silhouette.

Some may argue that it is perhaps unwise to try to duplicate the performance of the Zeiss instruments. We have found our method, however, highly popular and very successful.

PAUL S. WATSON
Maryland Academy of Sciences
Baltimore, Md.

IN NOVEMBER, at the South Boston Boys Club, the Boston Museum of Science opened a series of demonstrations of the country's first traveling planetarium. During the next two weeks club members, guests from the South Boston Girls Club, and school groups attended a total of 24 lectures before the dome was dismantled for transportation to its next "stand." In December, the traveling planetarium visited Center Sandwich, N. H., for one day, and then brought pre-Christmas stars to 1,500 students and school groups at Cathedral High School, in Boston's South End. In February, the planetarium is scheduled to operate at the American Academy of Arts and Sciences, in central Boston, in conjunction with an astronomy exhibit conducted by Harvard Observatory.

Key to the portability of the Boston Museum of Science planetarium is the sectional feature of its 18-foot 500-pound dome. A relatively light trailer is used to transport the eight sections of

(Right) Clyde Albee, of the Boston Museum of Science, is here stapling one of the eight sections of the portable dome, made of plywood pieces planed to a thickness of ⅛ inch.

(Below) John Patterson cutting out the skyline for the base of the dome, from photographic panoramas taken by him at the site where Boston's new museum of science is to be erected. The completed skyline in the upper portion of the picture shows at the right the new John Hancock Life Insurance Company building with a television mast on top.

Erecting the dome in the South Boston Boys Club. The segments are first fitted together on the floor — here three segments are in place. Blocks are placed under them so the dome may be lifted to a position about five feet high.

the dome, piled one on top of the other and covered with a tarpaulin. The trailer is drawn by a light truck, in which the Spitz projector and other equipment is carried, including a 5-inch Zeiss refractor. The seating capacity of the dome is 50, although nearly 60 school children have been accommodated at one time.

The Spitz projector has proven satisfactory, but the positions of a few stars have been improved by filling in the original holes with black wax pencil and punching others with the tip of a pair of dividers. Other stars which appeared too faint have needed only to have their perforations cleaned out with the divider tips. To provide smooth and quiet operation of the instrument by the lecturer, a control panel with silent jack switches has been wired into the original connections of the Spitz instrument. Rheostats control the brightness of the stars, the planets, and the dome lights. Also on the panel are switches for the music, which emanates from a microgroove record player installed inside the cabinet on which the projector is set. The loudspeaker for the music is located in the top of the dome, where there is also an air vent. The dome illumination is provided in very simple but effective fashion by an ordinary dark-green lamp shade, with light blue paper draped over the bulb to give a bluish tinge to the daytime sky.

As the Boston Museum of Science is at present occupying temporary quarters in a residence on Chestnut Street, Boston, the staff carpenter, Clyde Albee, had to construct the planetarium dome in a kitchen in the basement. He planned the eight segments so they could be removed through one of the kitchen doors. He tried many methods and materials. Laminated paper turned out to be too brittle. One layer of plywood was tried, but he found two thinner layers necessary for flexibility. As only ¼-inch plywood was available, he planed the stock to a thickness of about 1/8 inch. Then he cut it into thousands of pieces averaging six by 10 inches to fit them to the dome curvature. These he mounted on a mold of plaster and wire, glued them together and studded them with staples. In all there are 3,600 pieces of plywood, held together by 75 pounds of powdered glue and 45,000 staples.

Each segment of the dome overlaps the next and is held to it with bolts and wing nuts. The dome is supported by legs of aluminum channel bar, which are put into place after the dome is raised into position by five or six persons. Half a dozen stepladders help in the erection procedure. A light-tight curtain is hooked into metal runners below the dome skyline, and vents are placed at four points in the base of the curtain to allow air to enter the chamber. Attached to the vent in the zenith is a large flexible hose through which an exhaust fan in a portable unit continuously withdraws a large volume of air. The clearance required of the dome center is about 14 feet.

In December, the Boston Museum of Science announced that final papers had been signed with the Metropolitan District Commission for the lease of land for the erection of a museum of science, to be located on the dam at the foot of the Charles River Basin. Plans for the new museum include a connecting planetarium building, its 50-foot dome to house a larger projector.

The director of the traveling planetarium is Charles A. Federer, Jr., who has also been appointed director of Boston's permanent planetarium when it is erected.

BRADFORD WASHBURN, director
Boston Museum of Science

WE ACQUIRED our Spitz planetarium in the fall of 1947 in time for the celebration of the 50th anniversary of the Calvert School. As far as we know, ours was the first planetarium in Maryland, although the Maryland Academy of Sciences soon after installed one also.

Our oldest pupils are 12 years of age. We have used the planetarium for teaching elementary astronomy, not venturing into such fields as navigation. The instrument is set up in an ordinary classroom. The only modification made to the room was the installation of double blinds on the windows to make the room lightproof. To protect the machine we mounted it on a light table with casters; this can be rolled from the classroom into a specially constructed storage box.

Curiosity about how the machine worked was great, and before we began using it for science classes we arranged showings for all our pupils above the second grade, for parents of pupils, for alumni, and for the teachers and staff of the school. All who have witnessed a demonstration of the planetarium have been much impressed.

EDWARD A. HUEY
Assistant headmaster
Calvert School, Baltimore, Md.

FOR SIX MONTHS I have watched the progress made in using a Spitz planetarium for lecture work with the general public at the Stamford Museum in Connecticut.

At first I wondered how successful we would be in holding the interest of people who would have to travel only 35 miles to visit the Hayden Planetarium in New York City. But it did not take long to realize the importance of the role our small planetarium could play and that we were not really competing with the Hayden Planetarium. There are several reasons for the success that continues to grow from week to week.

The planetarium is mounted on a stand that can easily be rolled into position under the dome which serves as

the sky. Rubber caster cups are placed under the wheels to keep the projector from moving after it has been set up in the proper position. The dome can be easily raised out of the way and lowered into position as needed. Since our museum auditorium must serve as a lecture hall, classroom, and meeting place, as well as a planetarium, this ease of preparing for a talk is essential. It is only a matter of minutes to adapt our equipment for public appearance. The simplicity of a small planetarium makes for ease in checking last-minute details or taking care of minor repairs or changes.

Sky shows can be adjusted to suit the type of audience involved — if the lecturer can sense what those present would like to see or hear. Programs for children must be "down to earth" and in language that is easily understood. Star myths or some humorous personal methods of locating certain stars or constellations are often helpful in guarding against having a group of children become restless. One soon learns to gauge the proper amount of time for talks which will hold the audience just long enough. It is a good policy to stop at the peak of enthusiasm and interest, for then there is a stimulus for a return visit. It is important to remember that even an average adult audience derives much more pleasure from a talk that is simple than from too technical a one.

The planetarium can be used as a source of entertainment, but the same planetarium can also be used as a very important instrument of education. Here, as with adjusting talks to various age levels, a great deal depends upon the skill of the lecturer.

Groups interested in astronomy cannot always arrange time or transportation for trips to larger and more distant planetariums.

A small planetarium means more individual attention to visitors and more opportunities for them to ask questions. Such opportunities bring a satisfaction to all concerned and serve as a medium for establishing a friendliness with the public that is not so easily attained in larger institutions.

At the Stamford Museum our Spitz planetarium is especially useful as an educational aid. School groups, scout troops, day-camp groups, and the Stamford Amateur Astronomers keep the projector and dome in constant use. Regularly scheduled programs are presented twice weekly, and there are sometimes as many as 10 special showings during a week's time. An average group consists of 25 people and we have had as many as 50 under the dome at one time.

Recently a girl scout troop came for an after-school planetarium talk. These girls and their leader were anxious to learn at least 10 constellations for scout merit badge requirements. It hadn't been easy to arrange stargazing meetings at night and the museum's planetarium offered a fine solution to their problem. Under our seemingly magic dome the stars and constellations could be pointed out and studied with ease. Each girl could have a turn at holding the pointer and finding the constellation named by others of the group. Such a practice and drill session proved helpful and all concerned were high in their praise of the planetarium.

School teachers are equally enthusiastic about their trips to the museum for planetarium talks. A half hour under the dome is worth several hours of classroom explanation, in the opinion of these teachers, and they are glad to arrange to bring a group during school hours. This would indicate that school principals and superintendents endorse this type of visual education.

It has been a real adventure and a challenge to be a lecturer with a small planetarium.

FRANCES J. GILLOTTI
Educational director
The Stamford Museum

The dome of the Boston Museum of Science traveling planetarium is held up by aluminum channel supports fastened with wing nuts. Through the opening in the zenith a loudspeaker and air-exhaust vent are installed. Still to be attached is the curtain that extends completely around the dome between the horizon and the floor.

ASTRONOMICAL CONFUSIONS

I thought it would be fun, you see,
To learn about Astronomy.

I paid five dollars for a Book
Then hastened home to take a look.

Thought I, within these printed pages,
I'll find the secrets of the ages,

And now my life is one rotation
Of abstract figures and Equation.

Volumes, Density and Mass,
Weight, Velocity — Alas!

What is known as Opposition
Is a favorable condition.

Who would think that a Conjunction
Is a Planetary function?

Rocking Moons perform Librations
And Motion causes Aberrations.

Can you guess my Perturbation
Testing out Triangulation?

Just to make it more confusing
Add a Nebula Diffusing.

From Latitude Terrestrial
And Poles that are Celestial,

Spot a Star or Constellation
To train your eye in observation.

With Equinoxes, Faculae,
Novae, Nodes and Nebulae,

Azimuth and Apogee,
Zodiac and Galaxy,

Toss in terms like Troposphere,
Synodic and Sidereal Year,

Inverse Square, subtract and add,
Angles, Arcs, I'm going mad

Forming Circles in Ellipses,
Learning reasons for Eclipses.

Do you wonder that for me
Stars have changed to poetry.

In each Asteroid or Comet
Lurks an ode, mayhap a sonnet.

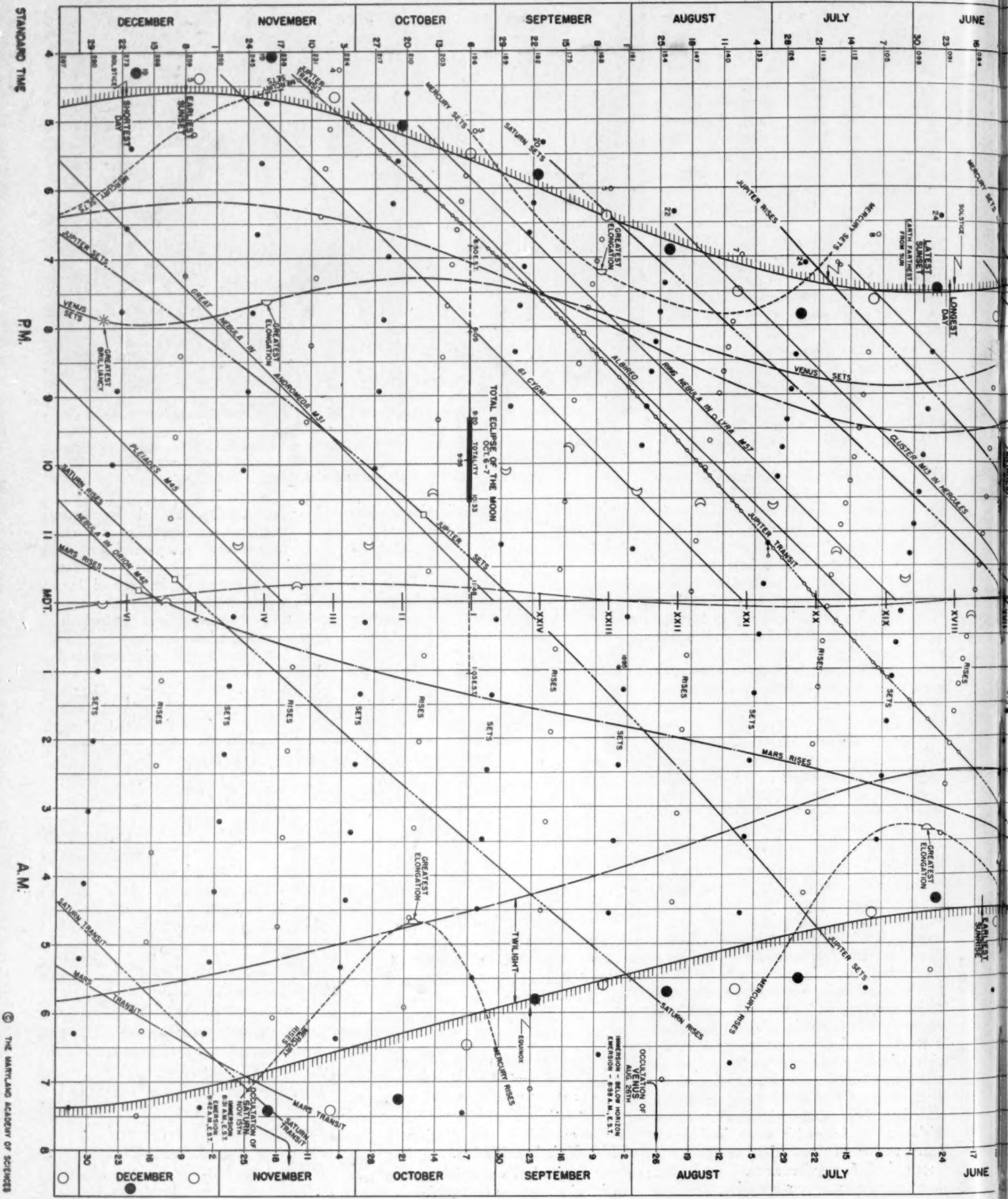
Must I be apologetic
For Energy that's not Kinetic,

Or waste it on Sidereal Time
When I might write a classy rhyme?

PAULINE F. PAUL

Graphic Time Table

PREPARED BY THE MARYL



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The Graphic Time Table of the Heavens

while still available may be secured without charge directly from the Maryland Academy of Sciences, Pratt Library Building, 400 Cathedral St., Baltimore 1, Md. Blueprints of the original drawing before reproduction are available at cost — 75c each — 40 x 27 inches. A Quebec edition, in French, for 47° N. and 75° W., is also available upon request.

The Graphic Time Table gives the rising and setting times of the sun, moon, and bright planets; the beginning of morning twilight and the ending of evening twilight; the times when certain stars and other objects of interest transit (cross the celestial meridian); phases of the moon; the equation of time; and other astronomical information. To illustrate by an example: The events of the night of January 6-7 may be found by following the horizontal line for that date across the graph from left to right. The Julian Day number for that evening is 2,432,923. The sun sets at 4:50 p.m., standard time; Mercury sets at 5:53 p.m.; Mars sets at 6:01; evening twilight ends at 6:25; the Pleiades transit at 8:39; Saturn rises at 8:47; the Great Nebula in Orion transits at 10:30; the first-quarter moon sets just after midnight. The curve for the equation of time shows that the sun is slow and will not be on the meridian until six minutes after 12 o'clock noon, local time, January 7th. Saturn transits at 3:27 the morning of the 7th; Venus rises at 5:38; morning twilight begins at 5:44; Jupiter rises at 7:05, and the sun rises at 7:22 a.m.

The dashes on the sunset and sunrise curves aid interpolation on intermediate days. Roman numerals show sidereal time at midnight. The phases of the moon are indicated by the conventional symbols. Small black circles show moonset for the first half of the lunar month, and small open circles show moonrise from full to new moon. Circles on the Jupiter transit curve indicate nights on which occultations, eclipses, or transits of Jupiter's bright moons occur between 7:00 and 11:00 p.m. EST. Small squares on planet curves indicate quadrature, and oppositions are marked by the conventional symbol.

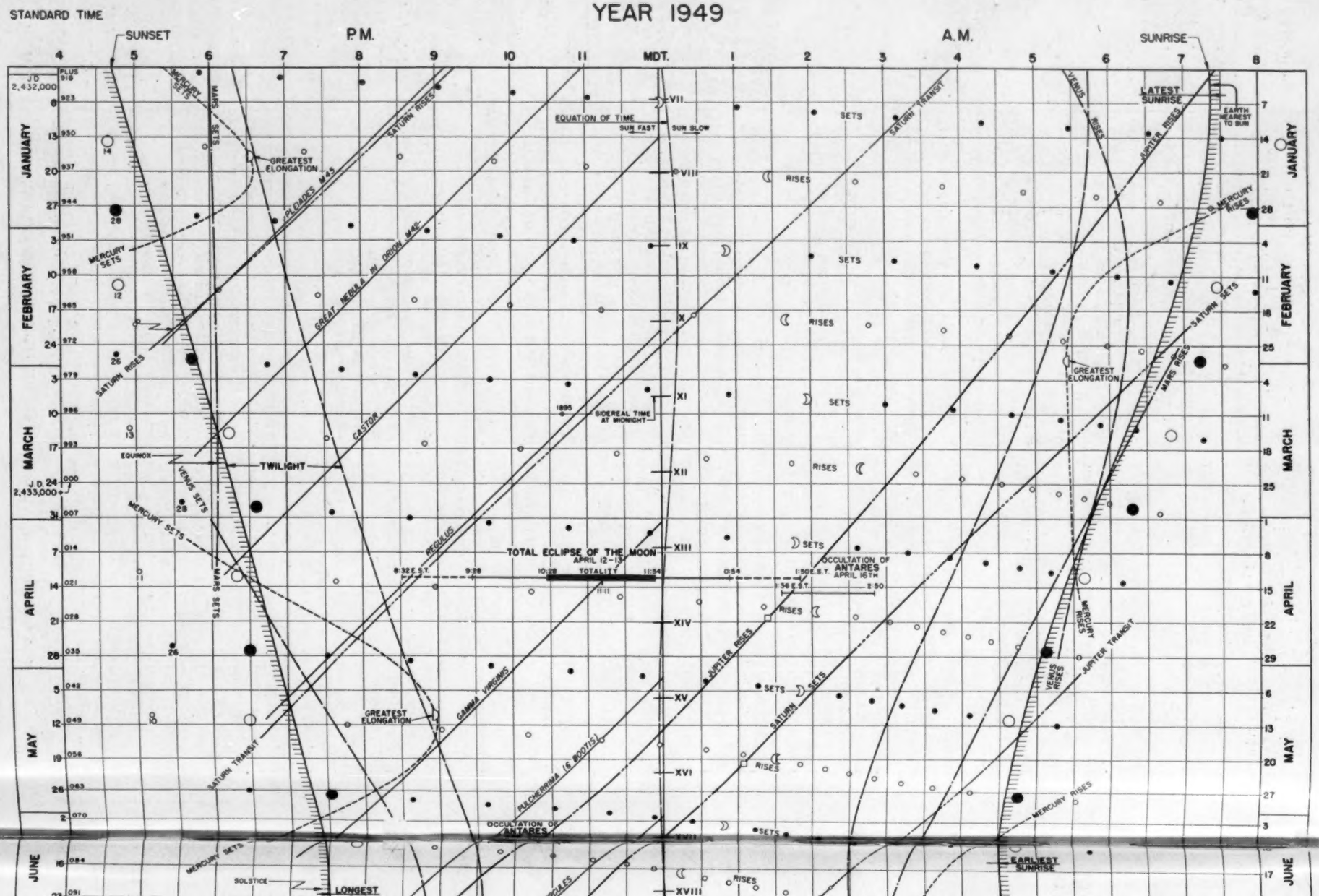
How to Correct for Your Position

As in all almanacs, times of rising and setting of sun, moon, and planets are absolutely correct for only one point on the earth's surface — for this chart: latitude 40° N. and longitude 90° W. The observer may easily correct for his own position. Latitude differences have comparatively minor effect and may in general be disregarded.

Correction for difference in longitude depends principally on the observer's distance east or west of his standard time meridian, which is always at an even multiple of 15°. Some corrections are tabulated here, in minutes of time:

Atlanta	+38	Detroit	+32	New Orleans	0
Baltimore	+ 6	Houston	+22	New York	— 4
Boston	—16	Indianapolis	—16	Pittsburgh	+20
Chicago	—10	Kansas City	+18	Rochester	+10
Cincinnati	+38	Los Angeles	— 7	San Francisco	+10
Cleveland	+27	Milwaukee	— 8	St. Louis	+ 1
Denver	0	Minneapolis	+13	Washington	+ 8

All places with plus correction are west of the standard meridian, and the events will occur later. The usual correction of one hour for each standard time zone must also be made to the Eastern standard times given for lunar eclipses and Jupiter's satellites, and in the Far West slight corrections may be made to times of moonrise and moonset. For times of occultations and solar eclipses, refer to the "American Ephemeris."



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BOOKS AND THE SKY

GEOLOGY APPLIED TO SELENOLOGY

Part III: Lunar Catastrophic History

J. E. Spurr. Rumford Press, Concord, N. H., 1948. 253 pages. $5.00.

IF MR. SPURR had no other virtues, his persistence would mark him as a phenomenon in these unstable days. Through 430 pages of an earlier volume of the first two parts of his study, and now through 250-odd pages of Part III, he pursues his set purpose to treat the moon as an exhibit of the action of forces here on earth called geological. No student or propounder of theories concerning the formation of lunar craters can afford to neglect this exhaustive work.

The meteoritic impact theorists seem to be all of the same mind, that if the lunar features do not resemble terrestrial formations then the moon's scarred surface cannot be the result of internal action. Scarcely any meteoriticist has failed to fall into this trap. Anyone who has accepted the existence of one completely non-lunar large meteorite crater on earth as proof that every feature on the moon can have been produced by impact should read Spurr's work.

It has been my experience that almost everyone who thinks about the lunar features conceives of two rather distinct ages for them. Some features are old, others are new. This is only a general impression, of course, but it appears to have influenced Spurr's thinking, because he believes that there were two very distinct climaxes in the moon's history, following its "capture" by the earth, by which term Spurr designates the fact that the moon keeps one face toward the earth. Indeed, the author lays the responsibility for the lunar catastrophes on the earth's capture of the moon.

A few million years, in all probability, sufficed for all of the features we now observe, according to Mr. Spurr, and the period since the last formation came into final form is many millions of years.

The geologists I have spoken with, who know something of the author's selenological studies, have complained that he breezes along a little too fast, recognizing faults and other structures where they perhaps do not exist, or at least could not well be assumed to exist from the superficial appearances only. There is no doubt that assurance and confidence mark every page of Spurr's detailed work. In this third section, as in the previous ones, he has extracted interesting regions and, by means of illuminating sketches, has made his meanings clear. It is doubtful if anyone has made a more thorough study of lunar photographs and maps, in recent times, with a view toward a unified hypothesis of origin of the formations.

Certainly no one who favors the impact hypothesis has made anything like as careful an attack on the whole visible lunar surface, which raises a very important question. How much of the lunar surface could really stand scrutiny on the impact hypothesis? Isn't it just the fact that the lunar formations are so much larger than terrestrial volcanoes that has led the impact proponents to say, without really examining the moon, that meteoritic collision could be responsible?

It has been almost impossible to locate craters on the moon that could be the results of impact. A crater 30 to 60 miles in diameter, yet only a mile or two in depth, simply cannot have been formed by impact. So some assistance is permitted from subsurface lunar forces. If those forces and materials can be used to assist impact, why can't they have worked without impact?

Spurr has been very bold in some of his concepts. Let geologists now jump on him, and show, from the same evidence, that he has been incorrect in his interpretation. But, above all, let the meteoriticists take a good look at the moon, to find an end to what seems to the reviewer to be a controversy one side of which has nothing on the moon to recommend its advancement. Let textbook writers stop pussyfooting about this matter, so they will not be quoted as favoring meteoritic impact. The argument is not whether a meteorite can produce a crater; the point in question is what happened on the moon. Spurr has accumulated a lot of discussion that will take a bit of doing to refute. His work must be read by everyone interested in the moon.

ROY K. MARSHALL
Fels Planetarium

PRACTICAL ASTRONOMY

George L. Hosmer and **James M. Robbins.** John Wiley and Sons, Inc., New York, 1948. Fourth edition, 355 pages. $4.50.

PRACTICAL ASTRONOMY

Jason John Nassau. McGraw-Hill Book Company, Inc., New York, 1948. Second edition, 311 pages. $5.00.

BOTH of these books are extensively revised editions of texts already long established in this field. Though each bears the same title, they cannot be said to be competitive texts in any real sense for they differ materially in viewpoint and in scope. Hosmer, originally published in 1910 and now rewritten by Robbins, is for the engineering student whose primary aim is to learn the job of determining time, latitude and longitude, for purely

NEW BOOKS RECEIVED

PRACTICAL SPECTROSCOPY, *Harrison, Lord,* and *Loofbourow,* 1948, *Prentice-Hall.* 605 pages. $6.50.

A text and reference book to help the worker in any branch of science evaluate the aid which the techniques of spectroscopy might lend to the solution of his own problems, written by a physicist, a chemist, and a biophysicist of the staff of Massachusetts Institute of Technology.

YANKEE SCIENCE IN THE MAKING, Dirk J. Struik, 1948, *Little, Brown.* 430 pages. $5.00.

A book about the growth in New England of science and technology from early colonial times to the Civil War. The relation of science to industry, politics, and the growth of cities is stressed, as well as the part New England science played in the development of the United States as a whole.

practical purposes and with limited equipment. Nassau, first issued in 1931, is for the student of civil engineering (primarily Part I), but even more for the student of astronomy and geodesy.

Readers of **Sky and Telescope** unacquainted with the technical usage of the words "practical astronomy" — in some respects an unfortunate term — may wonder about the implied division of astronomy into "practical" and "impractical." Practical astronomy is the time-honored term given to that branch of astronomy concerned with the determination of the angular relationship of the stars (considered as luminous geometrical points on the celestial sphere) to the observer. Such observations are necessary for the determination of those very practical items — time and place. But, in reality, all kinds of astronomical observations are practical in that they constitute the **practice** of an astronomer. The subjects traditionally included in practical astronomy are therefore really only a part of "practical" or observational astronomy.

The Nassau text aims at a basic understanding of the fundamentals of the subject and emphasizes precision of observation not attainable, nor needed, by the practicing engineer limited to the engineer's transit and sextant. Nassau treats in clear detail the use of the theodolite, the zenith telescope, and the astronomical transit as well as the engineer's transit. In addition, he discusses those relative newcomers to the field of practical astronomy, the prismatic and pendulum astrolabes, which simplify rather than complicate the determination of latitude and longitude, except where utmost precision is required.

It is surprising, however, with so much attention given by Nassau to modern instruments, that not even passing mention is made, for the benefit of the general background of the student, of the actual method used for the determination of the time by which we run our daily affairs — that employing the zenith tube of the U. S. Naval Observatory. A short description of this device is included in Hosmer. Neither book, however, mentions the zenith camera, a promising means of determining geographic positions, especially for rapid mapping purposes.

Many readers will find the Hosmer-Robbins book excellent for a descriptive survey of the problem generally included in practical astronomy, the locating of an observer in time and space (restricted here to the two-dimensional surface of the earth). Hosmer is basically nonmathematical, employing only so much mathematics as is absolutely essential. The style is clear and descriptive, and it follows that of the two books Hosmer is the more readable. The scope and objectives of the Nassau text, however, are so much greater, and the mathematical treatment necessarily much more extensive, that the two books cannot be considered as satisfying the same need. The Nassau book is clearly the best for the serious student of astronomy, while the Hosmer text is excellent for the elementary engineering student and for the general reader wishing to know something of how time and place on the earth can be determined.

J. ALLEN HYNEK
McMillin Observatory

ELEMENTS OF MATHEMATICAL ASTRONOMY

Martin Davidson. Hutchinson's Scientific and Technical Publications, London, 1947. 224 pages. 15s.

THIS BOOK is primarily intended for students of astronomy who would like to gain some familiarity with the application of elementary mathematics to their subject and who lack the opportunity of formal instruction. The first part of the book presents a systematic account of the geometry of the celestial sphere, the diurnal and annual motions, precession and nutation, time, refraction, aberration, and parallax. The fundamental formulae of spherical trigonometry are stated without proof and applied to the problems arising in the consideration of these topics. A great many numerical examples are solved in the text, and additional ones (with answers) are set as problems for the reader. This part of the book is on the whole a successful attempt to supplement the conventional elementary book on astronomy without going as far or becoming so difficult as a treatise on spherical astronomy. The nearest equivalent in English, Smart's **Foundations of Astronomy,** is far more complete, but perhaps for that reason apt to prove more formidable to the beginner working alone.

The chapters devoted to the law of gravitation, the moon, and the stars, are less successful. They are even sketchier than Dr. Davidson's self-imposed limitations demand and must be considered only as a connected set of elementary mathematical notes rather than as a self-contained account of these topics.

Part II of the book (59 pages) is on relativity, mostly on the special theory. Numerical examples of the Lorentz equations and the rules for the addition of velocities are given; these will probably prove helpful to readers who are otherwise restricted to the popular literature on this subject. Dr. Davidson seems to have chosen this topic (as well as the others in the book) in response to the desires expressed in communications from amateurs. But while the same individuals may have sought information about both spherical astronomy and relativity, the two subjects hardly belong together in one volume and the relativity might with advantage to the reader be replaced by an expansion of the spherical astronomy.

There are few slips, none of very great

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Griffith, P. O. Box 9787, Los Feliz Station, Los Angeles 27, Calif.
Hayden, Planetarium Book Corner, New York 24, N. Y.

Centennial Symposia

Interstellar Matter
Electronic and Computational Devices
Eclipsing Binaries
The Gaseous Envelope of the Earth

The papers presented at the December, 1946, meeting of the American Astronomical Society, in celebration of the centennial of Harvard College Observatory, have been collected in one volume. There are 24 papers under the four symposium titles, illustrated with plates and diagrams, presenting up-to-date evaluations of some of the most rapidly expanding phases of astronomy and related sciences. The first Henry Norris Russell lecture, given by Dr. Russell himself, surveys the present status of research on eclipsing binaries. The meteorology and astrophysics of the earth's gaseous envelope are treated in the concluding section of the book.

The authors are James G. Baker, Bart J. Bok, J. H. Dellinger, W. J. Eckert, Leo Goldberg, Jesse L. Greenstein, B. Haurwitz, Zdenek Kopal, Gerald E. Kron, Donald H. Menzel, R. M. Petrie, Walter Orr Roberts, Henry Norris Russell, Carl Schalen, Harlow Shapley, Lyman Spitzer, Jr., Joel Stebbins, Harlan T. Stetson, Otto Struve, H. C. van de Hulst, Fred L. Whipple, A. E. Whitford, H. C. Willett.

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The August 1948 issue includes the Halley lecture, "Morphological Astronomy," by F. Zwicky.

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The Skalnate Pleso ATLAS OF THE HEAVENS, designed and executed by Antonin Becvar and his associates, should prove invaluable to all amateur and professional astronomers. One of the charts, on a reduced scale, was reproduced and described in the November, 1948, issue of *Sky and Telescope*.

The atlas is printed on 100-pound stock, each chart area 15½ by 23½ inches. A title page, descriptive matter and a chart key are included. The set is shipped rolled, in a heavy mailing tube.

$5.00 postpaid

SKY PUBLISHING CORPORATION
Harvard College Observatory
Cambridge 38, Massachusetts

moment. The one most striking to an American reader gives the United States a share in the Atlantic standard time zone (on page 69). More attention to the business of significant figures would be an improvement. In a note on page 104, Dr. Davidson points out that some of the numbers he prints are not significant, but he prints them nevertheless.

R. I. WOLFF
College of the City of New York

NEWTON TERCENTENARY CELEBRATIONS

Various authors. The Macmillan Company, Cambridge University Press, New York, 1947. 92 pages. $3.00.

IN THE RUSH of modern living it is good to take time to ponder on the scientific giants of the past, in particular on the one who was so fortunate as to discover the basic law of the universe. These tercentenary papers present to the reader a picture of Newton which is clear, many-sided, and fascinating. The Royal Society celebrations of the 300th anniversary of his birth had of necessity been postponed from 1942, and were held in July, 1946. The address of welcome by Sir Robert Robinson, president of the Royal Society, contains the announcement of plans for the Isaac Newton Observatory with its 100-inch reflector.

Various aspects of Newton's life and works are considered by especially competent scholars. Professor E. N. Andrade, with the most comprehensive subject, "Newton," summarizes his life and achievements. Newton had reached some of his greatest intellectual heights by the time he was 24 years old. His genius received much recognition during his lifetime. He received the first knighthood to be conferred in England for scientific work, and was president of the Royal Society for 24 years.

The late Lord Keynes, who perused many of Newton's personal papers, wrote on "Newton, the Man," and has given a keen insight into Newton's life. "He regarded the universe as a cryptogram set by the Almighty."

Papers dealing with the technical side of Newton's work, and showing evidence of much study of the subject, are: "Newton and the Infinitesimal Calculus," by Professor J. Hadmard; "Newton and the Atomic Theory," by Academician S. I. Vavilov; and "Newton: the Algebraist and Geometer," by Professor H. W. Turnbull.

The influence of Newton's work on certain phases of modern science (which have now developed far beyond anything Newton could foresee) is discussed in papers by Professor N. Bohr, "Newton's Principles and Modern Atomic Mechanics"; by Dr. W. Adams, "Newton's Contributions to Observational Astronomy"; and by Professor J. C. Hunsaker, "Newton and Fluid Mechanics."

The volume is attractively bound and printed at practically prewar standards, and the six plates, including a facsimile of a holograph letter from Newton to Halley, are well selected to add interest.

HELEN SAWYER HOGG
David Dunlap Observatory

Planetarium Notes

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SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15, and 8:30 p.m.

STAFF: *Director*, Arthur L. Draper. *Other lecturers:* Nicholas E. Wagman, J. Frederick Kunze.

January: THE SOUTHERN CROSS. Visitors are transported magically to the Southern Hemisphere to see the Magellanic Clouds, the famous Southern Cross, and Alpha Centauri, nearest known star.

February: NEIGHBORS IN THE SKY and ROMANCE IN THE HEAVENS.

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STAFF: *Director*, Roy K. Marshall. *Other lecturers:* I. M. Levitt, William L. Fisher, Armand N. Spitz, Robert W. Neathery.

January: STORY OF THE CALENDAR. The evolution of our present calendar and suggestions for possible future improvement will be given.

February: STARS OF WINTER.

GRIFFITH PLANETARIUM

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STAFF: *Director*, Dinsmore Alter. *Other lecturers:* C. H. Cleminshaw, George W. Bunton.

January: THE WINTER SKY. The constellations and principal stars are pointed out, with aids for learning them, and discussion of what stars actually are. Some of the old myths are told.

February: BRIGHT COLORS IN THE SKY.

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STAFF: *Honorary Curator*, Clyde Fisher. *Chairman and Curator*, Gordon A. Atwater. *Other lecturers:* Robert R. Coles, Catharine E. Barry, Shirley I. Gale, Kenneth J. Heuer, William R. McDonald, Eugene L. Benedict, Frank H. Schleifer, Clarence V. Lee.

January: THE SKY PAGEANT OF 1949. This month we look ahead into the year for a preview of the many interesting and exciting celestial events that are going to occur.

February: OUR EXPLODING UNIVERSE.

MORE ABOUT THE FELS PLANETARIUM BREAKDOWN

THE BEARING whose failure interrupted operation of the Fels Planetarium instrument, as described in last month's *Sky and Telescope,* was repaired by SKF Industries in Philadelphia. The races of the large inner ring of the bearing were reground, and new forgings were made and ground for the outer races. Slightly oversize balls were then used to make a complete bearing. This represents a compromise between what the bearing is forced to do and the space permitted in the instrument for insertion of the bearing. The new bearing is slightly thicker than the original, and it was therefore necessary to alter the shims and spacers in the instrument.

Not only did SKF Industries rush the job through the laboratory in a single week, but they provided the new bearing without charge and had their experts guide the planetarium staff in the placing and lubrication of the unit. The complete reassembly of the planetarium required three days.

The failure of the Zeiss projector could have been caused by prolonged operation in an unbalanced condition, and the reassembly provided opportunity to discover, to our amazement, that the instrument in its original condition was badly out of balance. At one end of the daily-motion differential train a truncated cone counterweight of 36 pounds was removed to effect balance around the polar axis. Why this counterweight was ever put on by the manufacturer is a complete mystery.

One motor-and-drive system that was not disturbed in the dismantling is that which provides for change of latitude. The whole moving mass of the planetarium is turned in this motion around a horizontal east-west axis, supported on the fixed framework of the machine. This drive was disengaged when the assembly had been completed and the instrument was found to have been originally badly out of balance around this axis also. There had been an attempt to compensate for this by adding a ring of lead around the base of the south star ball, but this balance ring lacked approximately 40 pounds of being heavy enough. For some time, two small projector assemblies, called the name balls, have not been used in the Fels Planetarium. Each of these is normally attached to the extreme outer end of one of the large star balls — the balance of the instrument could be made practically perfect by adding the south name ball and leaving the north one off. Instead of this, however, the solar eclipse projector, built in the Fels Planetarium, was attached to the support formerly carrying the south name ball, and this put the instrument in perfect balance.

The improvement in balance is very evident as the instrument is operated. All of the motions are much quieter than ever before, and there are no sounds or other evidences of unequal distribution of weight in any position of the instrument. It is now practically certain that the central bearing would not have failed if the manufacturer had taken the trouble to make sure that the instrument was perfectly balanced.

ROY K. MARSHALL
Fels Planetarium

THE INDEX TO VOLUME VII

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SKY PUBLISHING CORPORATION

AN ETCHED CELESTIAL GLOBE

(Continued from page 64)

and their poles are painted.[2] The glass tubing shows the connection between the rotation of the earth upon its axis and the movement of the stars caused by rotating the neck of the flask.

The various co-ordinate systems for locating the stars can be readily taught with the globe. Students can read the right ascension and declination of a star directly from the numbered circles on the flask, and can see that they are the same for every observer. Altitude and azimuth, the co-ordinates of the horizon system, can readily be seen to depend upon the personal outlook of the observer, celestial latitude and longitude upon the plane of the earth's revolution, and the co-ordinates of the galactic system upon the structure of our galaxy.

As a visual aid, the celestial globe is valuable in making astronomical terms and laws concrete, but another value lies in inducing the student to visualize for himself, to exercise and train his own picture-making faculty—his imagination.

[2]Skilling, W. T., and Richardson, R. S. **Astronomy.** New York: Henry Holt, 1st edition, 1939, p. 37.

LETTER TO THE EDITOR

Sir:

From **Splendors of the Sky** and **Sky and Telescope** I am planning to cut star photos to mount on the outside of my 6-inch f/10 telescope tube to give it a more pleasing astronomical effect.

ROBERT LEONARD HYMAN
5929 Locust St.
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GLEANINGS FOR ATM's

Tile Tools and Paper Laps

WE HAVE USED a tile tool for over six years, and I not only recommend it to the mirror-grinding fraternity, but urge those who think they have finished their last instrument to make up a tile tool and do just one more mirror so that they may know the real joy to be had in grinding a mirror. Our Excelsior Telescope Club members are unanimous in the belief that this tool is the greatest improvement in mirror grinding since the discovery of carborundum. If we seem too enthusiastic, we believe that all ATM's will be after they have worked one.

The tile that I employed is the one-inch hexagon ceramic used extensively for flooring. Soak the tiles loose from the paper to which they are glued and wipe them clean. Then rub a very thin even coat of vaseline on the face of the mirror blank, and place one tile in the center of the disk. If you have the right thickness of vaseline, and press down hard, the tile will adhere firmly and will not skid around. In fact, there will be quite a suction when you try to lift it off, and that is what is desired. Finish placing the tiles on the glass, pressing each one firmly down, making the spaces between the facets ⅛ inch; 3/32 inch will work out but ⅛ inch is better.

On some mirror sizes, the tiles will just fill the glass, which is, of course, the ideal situation. On others, the marginal gaps may be filled in by breaking the tiles down to size — use one pair of pliers to hold a tile and another pair to break it. Thus small chunks can be nipped off until a nicely fitting fill-in piece of tile is obtained. Half or quarter holes should be filled in; do not bother with smaller ones, for a whole tile can be left out and not affect the working of the tool. Be sure that when all the tiles are down none of them protrudes beyond the edge of the mirror. I like to have my tools a good 1/16 inch smaller than the mirror.

Now place a heavy cardboard or tin around the mirror as if you were going to pour a lap, making it not more than one inch higher than the tile. This is thick enough for all mirrors up to 12 inches. Mix some Portland cement, thin enough so that it will pour from a spoon easily. Do not use any sand with the cement. Dip the cement with a spoon and pour it gently on the center tile. Carefully deposit cement on each tile until they are all covered. Finish filling the mold, smooth it off and let it set for 24 hours. (The reason for the caution in filling is to keep the tiles from skidding and to permit the thin, creamy mixture to settle down against the tile, leaving no loose pieces.)

At least a day later, remove the band, place the mirror against a stop on the work bench and carefully slide the tool from the glass. With an awl, scribe, or some other sharp-pointed instrument, scratch the cement from between the facets of the tiles. Remove the cement down to about the thickness of the tiles. I do this with a 3/32 high-speed drill bit by putting a stop on the bit so that it will go ⅛ inch deep. Running the drill press at medium speed, I swing the table out of the way, and holding the tool in my hands let the drill follow along between the facets to clean the cement away. However, if no drill press is available, the scratching works all right but it is slower. Care must be used so that the tiles will not be pried loose. After the channels are all cleaned out, let the cement harden thoroughly.

There are other variations which may be used, of course, such as waterproof glue to stick the tiles to a glass disk cut to size. Or they may be glued to a piece of metal turned to the proper size. We settled on the poured cement method as being the most satisfactory. It has the outstanding advantage of enabling one to form a tool to any curve which the mirror may have on it from any previous grinding. Or, if the usual glass tool has been broken, the grinder may pour his tile tool right on the curved surface of his mirror and proceed with further grinding.

With the tile tool, grinding time can be cut more than in half, with only four grades of carborundum. Be careful with your No. 80 or you will be too deep; it really works fast. Keep the channels cleaned out and apply the grit frequently,

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C. C. Young

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seeing that it is fairly well distributed over the tool. Wet the grit with a clothes sprinkler, the kind that can be bought at the 5 and 10. Fit the sprinkler on a Karo bottle and keep the No. 80 mud washed away. Use as many grades as you like but, as mentioned, four are plenty: Nos. 80, 220, 400, and 600. If the grinding time is spaced right, the mirror will have no pits at the edge. Each tile acts as a small tool in itself, and a beautifully uniform surface results.

With this method, there is complete freedom from jerking and skidding, and no dragging of the mirror. A 12-inch blank may be worked on this tool with less effort than an 8-inch on a conventional glass tool.

When you are ready for Nos. 400 and 600, get a Karo bottle and punch a hole in the top with an ice pick. Punch from the outside to obtain a smooth hole. Pour about half an inch of abrasive into the bottle with 1½ inches of water. Shake the mixture well and sprinkle a few drops on the tool. This is the best method of applying these grades that I have found. When you are sure that you have put in enough time with No. 600, set the bottle aside, and with your fingers pick up some of the mud from between the tiles and place a little on each one. Do not lift the mirror to do this but slide it first one way and then the other, and apply the mud to the exposed tiles. A few drops of water will have to be added frequently to keep the mirror from sticking. The results are really unbelievable. This is the only method I know of by which a mirror can be taken from the grinding tool and set up and checked with the Foucault test.

Now make a good paraffin lap. We use nothing else. In less than one hour you will have a polish that will equal about 40 hours of hard work on a mirror ground on the conventional glass tool.

As secretary and treasurer of the Excelsior Telescope Club, I shall be glad to hear from anyone who tries this tool, and will answer questions regarding the building of the tool or the working technique.

GEORGE F. JOYNER
12008 E. Sproul St.
Norwalk, Calif.

PAPER LAPS were employed by Foucault, but today one hears little of the use of paper for polishing among American amateurs. Therefore, some mirror makers who like to try out different ideas may be interested in an article by M. Daisomont in the **Gazette Astronomique**, March-April, 1947. Its translation into English, by Miss J. M. Flux, appeared in the September 30, 1947, issue of the **Monthly Notes** of the Astronomical Society of South Africa.

M. Daisomont takes issue with the Reverend W. A. Ellison's condemnation of paper laps (**Amateur Telescope Making**). He points out that Foucault made his excellent mirrors with paper laps, and that Dévé recommends the method in his book, **Le Travail des Verres d'Optique de Précision** (Paris, 1936). He believes polishing on paper to be at least as good as pitch polishing, to be simpler, cleaner, and easier to control, and says, "Paper laps can produce real gems."

It is not our intention to start a controversy on the relative merits of different types of laps, but it seems to us that some of Ellison's objections to paper laps are no longer tenable. For instance, paper is said not to be able to absorb the glass particles produced by the polishing action, so that scratching is likely to occur. But recent studies of the nature of the polishing action indicate that it is a kind of molecular flow and that glass particles are not removed from the surface being polished. Secondly, the use of thick, stiff paper seems unnecessary, as the French writer employs a good piece of duplicating paper "exactly 1/10 millimeter thick."

The paper is stuck to the tool with a light coating of paste on the back, leaving the outer side supple and velvety after treatment with a rather stiff brush. It

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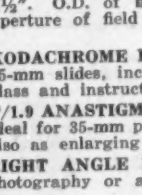

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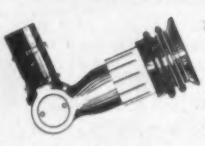

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goes without saying that the paste must be smooth and without lumps. The brush serves not only to bring the paper into continuous contact with the tool, but also prepares the surface to receive the rouge or other polishing agent. It is believed that, after the first few strokes, the paper is worn where it should wear in order to adapt itself exactly to the curve of the mirror.

We feel sure that there are some telescope makers who would like to try paper laps, and who may wish to describe their experiences to the readers of this department. The best way to determine the value of these simple laps is to experiment with them.

A CALENDAR FOR 4,000 YEARS

(Continued from page 63)

days intervening between September 2 and 14, 1752, were dropped. Minus 2, minus 11, and plus 13 cancel each other and we have no further use for them.

You should now have no trouble finding any date you want, but you are cautioned on one point, when the date occurs before February 29th in a leap year. For example, what day of the week is New Year's Day, A.D. 2004?

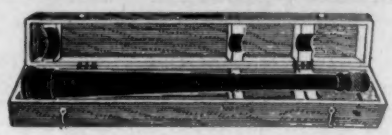
2004	
500	Do not use 501, but one less since the extra day in 2004 does not occur until February 29th.
20 minus	
5	
1	January 1st
2490	
355 + 5	Thursday

Finally, to take some current dates, those of the two lunar eclipses this year:

April 13, 1949		October 7, 1949	
1949		1949	
487		487	
19	minus	19	minus
4		4	
90		90	
13		91	
		92	
		7	
2524		2701	
360 + 4		385 + 6	
Wednesday		Friday	

TIDES IN THE ATMOSPHERE

The sun and the moon cause tides in our atmosphere as well as in the oceans. The solar air tide is much the higher, Dr. J. Bjerknes, of the Geophysical Institute of Bergen, Norway, reported to the National Academy of Sciences at Berkeley, Calif., in November, according to Science Service. The crests of the atmospheric tides come at 10 a.m. and 10 p.m. at sea level, but later at high levels. On a mountain 17,000 feet high, the crests come at noon and midnight. The amplitude of the tide is increased by the heating effect of the sun.



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City	*Organization*	*Date*	*Season*	*P.M.*	*Meeting Place*	*Communicate with*
ANN ARBOR	†*Ann Arbor A.A.A.	2nd Mon.	7:30	Oct.-June	U. of Mich. Obs.	Stewart W. Taylor, 1106 Birk Ave.
ATLANTA	Atlanta Ast'mers	3rd Fri.	7:30	Sept.-June	Agnes Scott College	W. A. Calder, Agnes Scott College
BATTLE CREEK	†B. C. A. A. Club	2nd Fri.	8:00	Oct.-June	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett St.
BEAVER, PA.	†*Beaver Co. A.A.A.	4th Tue.	8:00	Sept.-June	Com'y Bldg. Tamaqui	Mrs. R. T. LuCaric, Box 463, Baden
BROOKLYN, N. Y.	Astr. Dept.	3rd Thu.	8:15	Oct.-April	Brooklyn Inst.	Brooklyn Institute
BUFFALO	†*A.T.M.s & Observers	1st, 3rd Wed.	7:30	Oct.-June	Mus. of Science	R. Missert, 29 Crosby Ave., Kenmore
CAMBRIDGE	†*Bond Ast. Club	1st Thu.	8:15	Oct.-June	Harvard Obs.	Miriam Dickey, Harvard Observatory
"	†*A.T.M.s of Boston	2nd Thu.	8:00	Sept.-June	Harvard Obs.	Frank M. Roe, 35 Pemberton St. (40)
CHATTANOOGA	Barnard A. S.	2nd Fri.	8:00	Oct.-May	Jones Observatory	C. T. Jones, 302 James Bldg., *CHat.* 7-1936
CHICAGO	†*Burnham A. S.	2nd Tue.	8:00	Sept.-June	Chi. Acad. of Sciences	J. M. Showalter, 6200 Kenmore Ave.
"	Chicago A. S.	Monthly	8:00	.....	Adler Planetarium	Adler Plan., *Wabash* 1428
CINCINNATI	*Cin. A. A.	2nd Fri.	8:00	Sept.-June	Cincinnati Obs.	T. R. Stoner, RR 8, Cin. 30, *BE* 7937-R
"	*Cin. A. S.	3rd Wed.	8:00	Sept.-June	5556 Raceview Ave.	A. C. Moore, 5548 Raceview Ave. (11)
CLEVELAND	Cleveland A. S.	Fri.	8:00	Sept.-June	Warner & Swasey Obs.	Virginia Burger, Warner & Swasey Obs.
COLUMBIA, S. C.	North'n Cross A.S.	Every Mon.	8:15	All year	Melton Observatory	Dr. L. V. Robinson, Univ. of S. C.
COLUMBUS, OHIO	*Columbus A. S.	Last Tue.	8:00	All year	McMillin Obs.	J. A. Hynek, Ohio State Univ.
DAYTON	A.T.M.s of Dayton	3rd Sat.	Eve.	.....	Private homes	W. C. Braun, New Lebanon
DAYTONA BEACH	D. B. Stargazers	Alt. Mon.	8:00	Nov.-June	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
DETROIT	†*Detroit A. S.	2nd Sun.	3:00	Sept.-June	Wayne U., Rm. 187	E. R. Phelps, Wayne University
"	†*N. W. Detroit A.S.	1st Tue.	8:00	Sept.-June	Redford High Sch.	John W. Broxholm, 21412 Pickford
DULUTH. MINN.	†*Darling Ast. Club	1st, 3rd Fri.	8:00	All year	Darling Observatory	R. H. Schmidt, 1910 Hughitt, Superior
GADSDEN, ALA.	Ala. A. A.	1st Thu.	7:30	All year	Ala. Power Audit.	Brent L. Harrell, 1176 *W* or 55
GENEVA, ILL.	*Fox Valley A. S.	1st Tue.	8:00	.....	Geneva City Hall	Joseph Zoda, 501 S. 6th, St. Charles
GREENSBORO, N. C.	†*Greensboro A. C.	1st Thu.	8:00	All year	Woman's Coll., U.N.C.	H. M. Holliday, 804 Oakland Ave.
HOUSTON	Houston A. S.	Last Fri.	7:30	All year	Mus. Nat. Hist. Annex	Mrs. Johnnye Murray, 1007 W. Gray (6)
INDIANAPOLIS	†Indiana A. S.	1st Sun.	2:15	All year	Riley Library	E. W. Johnson, 808 Peoples Bank Bldg.
JACKSONVILLE	*J. A. A. C.	1st, 3rd. Mon.	8:00	All year	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
JERSEY CITY, N. J.	†Revere Boys Club	Mon., Tue.	7:15	All year	Gregory Mem. Obs.	Enos F. Jones, 339 Wayne St.
JOLIET, ILL.	†Joliet A. S.	3rd Mon.	8:00	Oct.-May	Jol. Township H. S.	Mrs. Robert L. Price, 403 Second Ave.
KALAMAZOO	†Kalamazoo A.A.A.	Sat.	8:00	Mar.-Dec.	Private homes	Mrs. G. Negrevski, 2218 Amherst, 31482
KANSAS CITY	*A. A. & T. M.s	4th Sat.	8:00	All year	Private homes	Reginald Miller, Merriam, Kans.
KEY WEST, FLA.	†Key West Ast. Club	1st Wed.	8:00	All year	Private homes	W. M. Whitley, 1307 Div. St., 724-R
LANSING, MICH.	†*Lansing A. A.	1st, 3rd Wed.	8:00	Sept.-June	Technical H. S.	Mrs. T. A. Louden, 940 Bensch St., (14)
LOS ANGELES	L.A.A.S.	2nd Tue.	7:45	.....	Griffith Obs.	H. L. Freeman, 853½ W. 57 St.
LOUISVILLE, KY.	†L'ville A. S.	1st Tue.	8:00	Sept.-May[1]	Univ. of Louisville	B. F. Kubaugh, 621 34th St.
MADISON. WIS.	†Madison A. S.	2nd Wed.	8:00	All year	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
MIAMI, FLA.	South'n Cross A.S.	Every Fri.	7:30	All year	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26th Road
MILWAUKEE	†*Milw. A. S.	1st Thu.	8:00	Oct.-May	U. of Wisc. Ext. Div.	E. A. Halbach, 2971 S. 52 St., W. Allis
MINNEAPOLIS	M'polis A. C.	1st, 3rd Wed.	7:30	.....	Public Library	Mrs. M. S. Skahen, 500 Ridgew'd Ave. (4)
MOLINE. ILL.	†*Pop. Ast. Club	Wed.[2]	7:30	Feb.-Nov.	Sky Ridge Obs.	Carl H. Gamble, Route 1
MONTREAL, P. Q.	RASC, Montreal	Every Sat.[3]	8:00	All year	4052 Wilson Av.	DeLisle Garneau, DExter 1802
NASHVILLE	*Barnard A. S.	2nd Thu.	7:30	All year	Vanderbilt Univ.	E. Keller, 2716 Hartford Dr. (11), 5-0766
NEW HAVEN	†New Haven A.A.S.	4th Sat.	8:00	Sept.-June	Yale Obs.	Mrs. Eda Becroft, Box 28, Yalesville
NEW ORLEANS	A.S. of N. Orleans	Last Wed.	8:00	Sept.-May	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
NEW YORK	*A.A.A.	1st Wed.	8:00	Oct.-May	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *EN.* 2-8500
"	†Junior Ast. Club	4th Fri.	7:30	Sept.-May	Amer. Mus. Nat. Hist.	J. B. Rothschild, Hayden Plan., *EN.* 2-8500
NORFOLK, VA.	†*A.A.S. of Norfolk	2nd, 4th Mon.	8:00	All year	Commonwealth Apts.	P. N. Anderson, 2320 Ballentine Blvd. (2)
NORWALK, CAL.	Excelsior Tel. Club	Thu.	7:00	All year	Excelsior Union H. S.	Geo. F. Joyner, 410 Sproul St.
NORWALK, CONN.	Norwalk Ast. Soc.	Last Fri.	8:00	Sept.-June	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-5947
OAKLAND. CAL.	*Eastbay A. A.	1st Sat.	8:00	Sept.-June	Chabot Obs.	Miss H. E. Neall, 1626 Chestnut, B'keley
OWENSBORO, KY.	†*Owensboro A. C.	3rd Sat.	8:00	All year	Public Library	Herman Batt, 1507 Hathaway St.
PALO ALTO, CAL.	†*Ast. & Tel. Club	1st Fri.	7:30	All year	Community Center	Miss D. Rossiter, 922 Roble Ave., Menlo Pk.
PHILADELPHIA	†A. A. of F. I.	3rd Fri.	8:00	All year	The Franklin Inst.	Edwin F. Bailey, *Rit.* 3050
"	*Rittenhouse A. S.	2nd Fri.	8:00	Oct.-May	Morgan Physics, U. Pa.	Sarah Lippincott, Sproul Obs., Swarthmore
PITTSBURGH	†*A.A.A. of P'burgh	2nd Fri.	8:00	Sept.-June	Buhl Planetarium	Charles H. LeRoy, R. D. 2 (15)
PONTIAC, MICH.	*Pontiac A.A.A.	2nd Thu.	8:00	All year	Private homes	Mrs. M. Chircop, 147 Prospect St., 21455
PORTLAND, ME.	†A. S. of Maine	2nd Fri.	8:00	All year	Private homes	H. M. Harris, 27 Victory Ave., S. Portland
PORTLAND, ORE.	†*Portland A. S.	1st Wed.	7:00	All year	Central Pub. Lib.	H. J. Carruthers, 427 S. E. 61 Ave.
"	†A. T. M. & O.'s	2nd Tue.	8:00	All year	Private homes	N. C. Smale, 831 N. Watts St.
PROVIDENCE, R. I.	Skyscrapers, Inc.	Mon. or Wed.	8:00	All year	Ladd Observatory	Ladd Obs., Brown U., *GA.* 1633
RENO, NEV.	A. S. of Nev.	4th Wed.	8:00	All year	Univ. of Nevada	G. B. Blair, University of Nevada
ROCHESTER, N. Y.	Roch. Ast. Club	Alt. Fri.	8:00	Oct.-May	Univ. of Rochester	Edwin M. Root, 110 Hamilton St.
ROCKY MOUNT, N.C.	Hi-Y A. C.	Tue.	8:00	.....	YMCA	J. A. Harper, YMCA
RUTHERFORD, N. J.	Rutherford A. S.	1st Thu.	.....	.....	Private homes	W. C. Fillebrown, 273 Lawton Ave.
SACRAMENTO	*Sac. Val. A. S.	1st Tue., bi-mon	8:00	All year	Sacramento College	Mrs. Helen Schopke, 3111—12 Ave. (17)
SAN DIEGO, CAL.	Ast. Soc. of S. D.	1st Fri.	7:30	Oct.-June	504 Elec. Bldg.	W. T. Skilling, 3140 Sixth Ave.
"	†A.T.M. Ast. Club	2nd, 4th Mon.	7:30	All year	3121 Hawthorn St.	G. A. Sharpe, 4477 Muir, *Bayview* 3757
SCHENECTADY	†S'tady Ast. Club	3rd Mon.	8:00	All year	Schenectady Museum	G. Staffa, 32 Front St.
SOUTH BEND, IND.	St. Jos'ph Val. Ast.	Last Tue.	8:00	All year	928 Oak Street	F. K. Czyzewski, South Bend Tribune
SPRINGF'D, MASS.	†S'field Stars	2nd Wed.	8:00	All year	Private homes	F. D. Korkosz, Mus. Nat. Hist., 2-4317
SPRINGFIELD, VT.	†Springfield T. M.'s	1st Sat.	6:00	All year	Stellafane	John W. Lovely, 27 Pearl St., 535-W
ST. LOUIS	St. Louis A. A. S.	1st Sat.	.....	All year	Private homes	A. M. Obrecht, 2913 Park Ave.
STAMFORD, CONN.	*Stamford A. A.	3rd Fri.	8:00	All year	Stamford Museum	Wm. L. Dutton, Box 331, Noroton
TACOMA, WASH.	Tacoma A. A.	1st Mon.	8:00	All year	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 No. Union Ave.
TEANECK, N. J.	†Bergen Co. A. S.	2nd Wed.	8:30	All year	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
TULSA, OKLA.	†Tulsa A. S.	Occasional meetings				V. L. Jones, 4-8462
WANTAGH, N. Y.	Long Island A. S.	Sat.	8:00	All year	Private homes	A. R. Luechinger, Seaford Ave., 1571
WARREN, OHIO	†Mahoning Val. A.S.	Thu.[4]	8:00	All year	Private homes	S. A. Hoynos, 1574 Sheridan, N.E., 25034
WASHINGTON, D.C.	†Nat'l Cap. Ast'mers	1st Sat.	8:00	Sept.-June	U.S. Nat'l. Museum	Jewell Boling, 1717 P St. N.W., *Du.* 2969
WICHITA, KANS.	†*Wichita A. S.	1st Wed.	8:00	All year	To be announced	Dollie Ratcliff, 801 Maple, 2-1822
WINSTON-SALEM	†*Forsyth A. S.	Last Fri.	7:30	All year	Private homes	Kenneth Shepherd, 703 W. E. Blvd.
WORCESTER, MASS.	†*Aldrich Ast. Club	1st, 3rd Tue.	7:30	All year	Mus. Natural History	Ralph A. Wright, 4 Mason St.
YAKIMA, WASH.	†Yak. Am. Ast'mers	1st Fri.	8:00	All year	Cha. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.
YOUNGSTOWN	Y'town A. C.	2nd Mon.	7:30	All year	Homestead Pk. Pav'n.	F. W. Hartenstein, 905 Brentwood

[1]June, Jul., Aug., informal meetings. [2]Nearest 1st-quarter moon. [3]Observation meetings. [4]1st or 2nd Sun., June-Sept.

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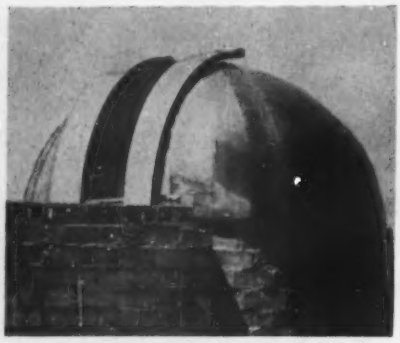

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

Magnitude Determinations of Saturn's Satellites

MANY OBSERVERS have suspected that the magnitudes of some of the satellites of Saturn are variable. In spite of the fact that this planet and its satellites have been very much observed by generations of astronomers, the matter remains indeterminate. It is also not known whether or not the inner satellites rotate once or more than once in a revolution, and whether or not they possess atmospheres.

The British Astronomical Association is sponsoring amateur observational work in this connection, with the object of either determining that the magnitudes of the satellites are invariable or, if not, of securing their light curves. With sufficient information of the above nature, it should be possible to determine the rotation periods of some of the satellites, depending on the permanence of the markings causing the possible variations in brightness.

The determinations are made difficult, even with relatively large instruments, by the glare of the planet and its rings. Except for Titan, which is of magnitude 8.3, the satellites are of the 10th magnitude or fainter, and are best seen at their elongations east and west of the planet. The rings normally interfere considerably with the satellites' visibility in certain positions. It has been suggested that interested amateurs, of which this writer is one, make an attempt at observing these satellites during the present favorable opposition, for the rings are now rapidly closing. This should make us ready for the conditions of early 1950, when the rings will so nearly disappear that for a considerable time Saturn and its satellites will resemble Jupiter.

The ideal way of measuring the brightness of objects such as Saturn's satellites is by means of a photoelectric or optical photometer. Most amateurs, however, are not possessed of such instruments, and must rely on visual estimates. The Saturn section of the British Astronomical Association suggests the possibility of estimating magnitude differences in tenths using Titan as a base, assuming its brightness to be constant at magnitude 8.3. Variable star observers commonly employ this step-estimating system. In any one series of estimates made at the same time, each satellite is in turn used as a base for the estimated interval to the next fainter satellite.

Greater accuracy would be possible with standard magnitude sequences of faint stars along the planet's path. Perhaps, for the 1950 opposition, professional astronomers will supply such information, particularly for faint stars near enough to the path to be dimmed by Saturn's glare to the same extent as are the satellites themselves. Meanwhile, the step-estimating method should be of some value, especially in the case of Iapetus, which appears to show a great difference in light at eastern and western elongation. Its normal magnitude is 11, but its range is said to be as much as from 10.1 to 11.9.

In making these observations, special care is needed to identify the fainter satellites, which may easily be confused with faint stars in the field and with one another. Elsewhere in this department are a chart and instructions for determining the positions of Saturn's satellites at any time. Naturally, any estimates of magnitude should include the position of the satellite and the time of the observation. The writer will be glad to hear from any amateurs possessed of telescopes suitable for making these observations.

ROLLAND R. LaPELLE
54 Fernleaf Ave.
Longmeadow 6, Mass.

EVENTS IN 1949

This year we are to have two total lunar eclipses, one of magnitude 1.432 on April 12-13, and the other of magnitude 1.228 on October 6-7; these are the first such events visible in the Western Hemisphere in several years.

Saturn's rings are tilted only seven degrees now, and by December they will be but 1½ degrees from appearing as a straight line. From August, 1945, until late in November, 1948, there were no transits, shadow transits, eclipses, or occultations of Jupiter's fourth bright satellite, Callisto, but during the coming three years such phenomena will take place regularly.

Venus will be occulted in August, and Saturn in November, as seen from the eastern states. A grazing occultation of Mercury is listed for April 29th at Vancouver. A series of occultations of Antares begins in February, with those of April and June observable from the eastern United States, and the August event visible farther west. The moon will begin to occult some of the stars in the Pleiades.

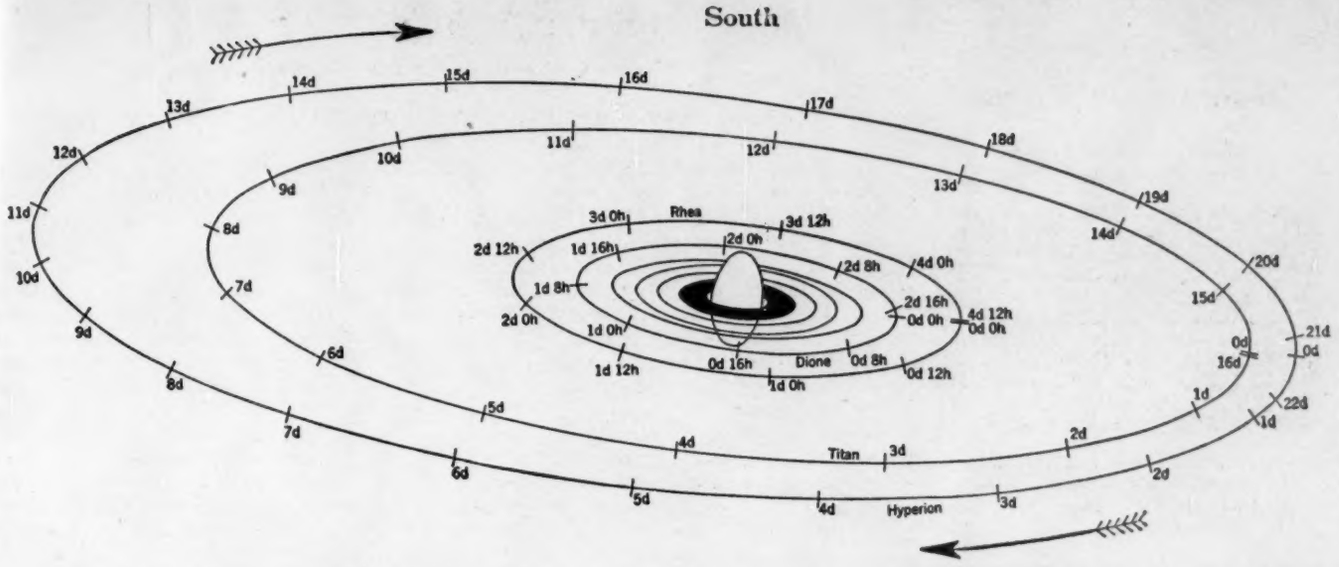
In addition to the conjunction of Venus and Jupiter this month, Saturn and Venus will be only 10 minutes of arc apart on July 31st, and on November 30th Mars and Saturn will be separated by nine minutes of arc. EDWARD ORAVEC

JANUARY METEORS

The Quadrantid meteor shower may be observed the first week of January, with maximum on the 3rd. Rates are 40 per hour at maximum, and the radiant is at 230°, +52°, according to the BAA **Handbook** for 1949. This is in Bootes, circumpolar at latitude 40° north. E. O.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.



Apparent orbits of the seven inner satellites of Saturn, at the time of opposition, February 21, 1949, as seen in an inverting telescope, and elongated in the ratio of two to one in the direction of their minor axes.

HOW TO IDENTIFY THE SATELLITES OF SATURN

IN THE DIAGRAM reproduced here from the **American Ephemeris and Nautical Almanac** the eastern elongation point of each satellite's orbit is marked 0d 0h or 0d (except for the three inner satellites). The times of eastern elongations are listed in the **Ephemeris,** and some selected elongation times are given in this article. The apparent position of a satellite at any time may be marked on the diagram by setting off on the proper orbit the elapsed interval in days and hours since the last eastern elongation. The orbits of the five inner satellites are regarded as circular; but for Titan, Hyperion, and Iapetus (orbit not shown), the eccentricity is taken into account. The satellites, with their apparent angular distances from the planet (as seen from the sun) are:

Satellite	Synodic Period		Magnitude	Mean Distance
	days	hours		
Mimas	0	22.6	12.1	27″
Enceladus	1	8.9	11.6	34″
Tethys	1	21.3	10.5	43″
Dione	2	17.7	10.7	55″
Rhea	4	12.5	10.0	76″
Titan	15	23.3	8.3	177″
Hyperion	21	7.6	13.0	214″
Iapetus	79	22.1	10.1-11.9	515″
Phoebe	523	15.6	14.5	1870″

For the first five satellites listed below the times given are for eastern elongations only, every fifth one in the case of Mimas and every third one for Enceladus, Tethys, Dione, and Rhea. For Titan, Hyperion, and Iapetus, the configurations around the orbit are: E, eastern elongation; I, inferior conjunction; W, western elongation; S, superior conjunction. In all cases the month is given, then the day of the month and the hour of the day in tenths, Universal time. For instance, for Titan the first item is a western elongation which occurs on January 1st at $2^h.7$ UT.

Mimas. January: 0, 15.3; 5, 8.3; 10, 1.4; 14, 18.5; 19, 11.6; 24, 4.7; 28, 21.7. February: 2, 14.8; 7, 7.8; 12, 0.9; 16, 18.0; 21, 11.0; 26, 4.1. March: 2, 21.2; 7, 14.3; 12, 7.4; 17, 0.4; 21, 17.5; 26, 10.5; 31, 3.6.

Enceladus. January: 0, 4.7; 4, 7.4; 8, 10.0; 12, 12.6; 16, 15.2; 20, 17.9; 24, 20.5; 28, 23.2. February: 2, 1.8; 6, 4.4; 10, 7.1; 14, 9.7; 18, 12.3; 22, 14.9; 26, 17.6. March: 2, 20.2; 6, 22.8; 11, 1.5; 15, 4.1; 19, 6.8; 23, 9.4; 27, 12.1; 31, 14.7.

Tethys. January: 1, 5.5; 6, 21.4; 12, 13.3; 18, 5.2; 23, 21.1; 29, 12.9. February: 4, 4.8; 9, 20.7; 15, 12.6; 21, 4.5; 26, 20.4. March: 4, 12.2; 10, 4.1; 15, 20.0; 21, 11.8; 27, 3.7.

Dione. January: 0, 15.9; 8, 21.0; 17, 1.9; 25, 6.9. February: 2, 11.8; 10, 16.9; 18, 21.8; 27, 2.8. March: 7, 7.7; 15, 12.6; 23, 17.6; 31, 22.6.

Rhea. January: 3, 17.5; 17, 6.6; 30, 19.6. February: 13, 8.6; 26, 21.6. March: 12, 10.6; 25, 23.6.

OCCULTATION PREDICTIONS

January 4-5 **Psi² Aquarii** 4.6, 23:15.3 −9-27.7, 6, Im: **A** 21:23.7 −2.1 +0.4 75°; **C** 21:11.7 −2.3 +0.7 73°. Em: **A** 22:39.5 −0.7 +1.3 204°; **C** 22:30.6 −0.9 +1.6 205°.

For selected occultations visible at standard stations in the United States and Canada under fairly favorable conditions, these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, a and b quantities in minutes, position angle; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	**E** +91°.0, +40°.0
B +73°.6, +45°.6	**F** +98°.0, +30°.0
C +77°.1, +38°.9	**G** +114°.0, +50°.9
D +79°.4, +43°.7	**H** +120°.0, +36°.0
	I +123°.1, +49°.5

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your own standard time.

Titan. January: W, 1, 2.7; S, 5, 7.1; E, 9, 7.8; I, 13, 2.5; W, 17, 0.8; S, 21, 5.1; E, 25, 5.7; I, 29, 0.4. February: W, 1, 22.5; S, 6, 2.7; E, 10, 3.4; I, 13, 22.0; W, 17, 20.0; S, 22, 0.2; E, 26, 0.9. March: I, 1, 19.6; W, 5, 17.4; S, 9, 21.6; E, 13, 22.5; I, 17, 17.2; W, 21, 15.0; S, 25, 19.2; E, 29, 20.2.

Hyperion. January: E, 0, 21.9; I, 5, 11.1; W, 11, 12.6; S, 17, 13.8; E, 22, 2.6; I, 26, 15.8. February: W, 1, 17.3; S, 7, 18.5; E, 12, 7.4; I, 16, 20.4; W, 22, 21.9; S, 28, 23.4. March: E, 5, 12.5; I, 10, 1.4; W, 16, 2.9; S, 22, 5.0; E, 26, 18.4; I, 31, 7.4.

Iapetus. January: I, 12, 5.9; W, 30, 21.6. February: S, 19, 16.1. March: E, 12, 3.6; I, 31, 11.8.

Mappa Coelestis Nova

A striking new wall chart by Josef Klepesta shows the stars brighter than magnitude 5.0 in six different colors according to their spectral classes. Centered on the north pole, the map extends to 45° south declination, and is 25½ inches in diameter. The geometrical constellation patterns are shown in fine solid lines, and constellation boundaries are indicated by dotted lines. The star name or number, Greek letter, and visual magnitude to hundredths are given for each star. Mappa Coelestis Nova is decorative, and provides in an unusual form a mine of information for the stargazer.

$3.50 postpaid

Moon Sets

Eighteen full-sized plates, nine of the first-quarter and nine making the last-quarter moon, from Lick Observatory negatives. Printed on heavy coated stock, each plate on a sheet 12 x 18 inches. Included on a separate sheet are 18 key charts of named lunar features.

$2.00 postpaid

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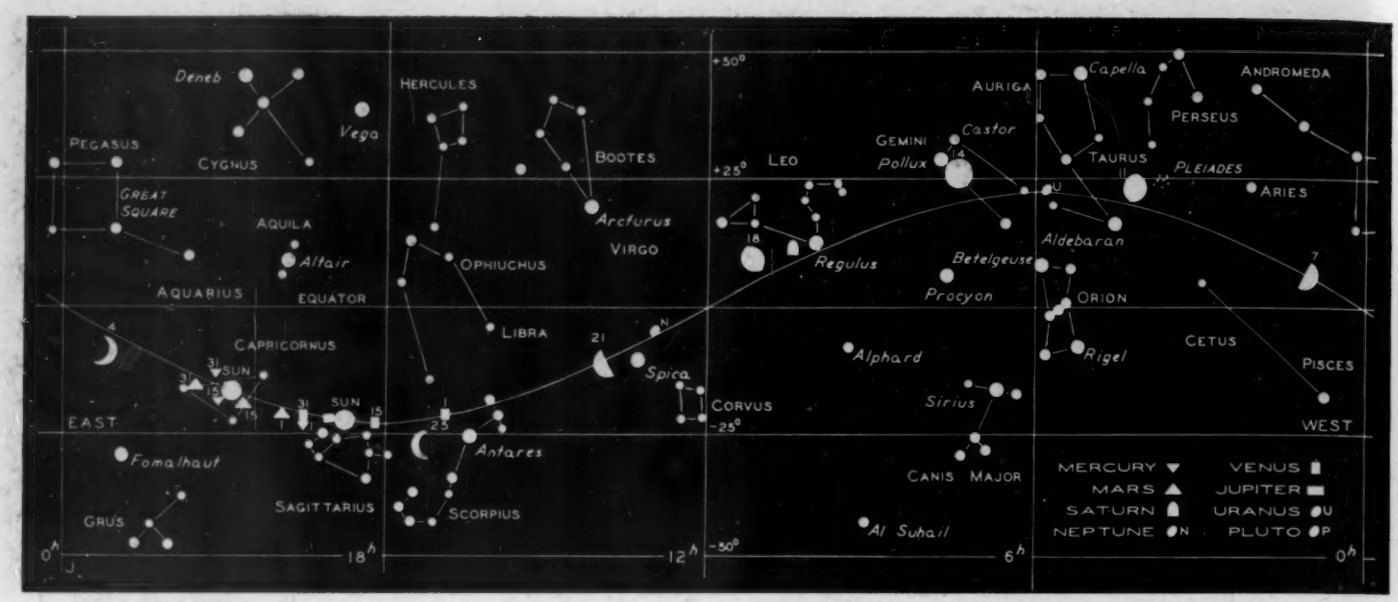


PHASES OF THE MOON

First quarter	January	7, 11:51
Full moon	January	14, 21:59
Last quarter	January	21, 14:07
New moon	January	29, 2:42
First quarter	February	6, 8:05

SKY-GAZERS EXCHANGE

Classified advertisements for this column are 8 cents a word, including address; minimum ad 20 words. Remittance must accompany orders. Write Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.

FOR SALE: Mounted 4", 5", and 6" refractor objectives of first quality. $100.00, $200.00, $300.00. Correspondence invited. Earl C. Witherspoon, Sumter, S. C.

FOR SALE: Amateur-built 112x 6" reflecting telescope and equatorial mount plus Ramsden eyepiece. $50.00 or best offer. Particulars on request. Donald C. Gaby, Homestead, Fla.

FOR SALE: Professionally made new 4" refractor, coated optics, equatorial mount, setting circles, slow motion, star diagonal, finder, three eyepieces plus one for sun, tripod, $500.00. F. C. Hill, 430 Aquila Court, Omaha, Nebr.

FOR SALE: Chrome rack-and-pinion focusers, with extension tube; detachable curved base plate with collimating screws. Special $10.50 each. Valley View Observatory, 106 Van Buren St., Pittsburgh 14, Pa.

FOR SALE: New, finest quality, Brandon air-spaced mounted 4" refractor objective, 60" focal length, as advertised in February, 1948, **Sky and Telescope**, $130.00. Harold Cadek, 421 Walnut St., Chattanooga, Tenn.

ASTRONOMICAL BOOKS, magazines, etc., bought and sold. Send your wants and lists to Charles Benevento, 83 Hoyt St., Brooklyn 2, N. Y.

FOR SALE: Carl Zeiss Jena 60-mm. telescope. 21, 47, 94 power. Celestial and solar eyepieces. Erecting and zenith prisms. Fine adjustment controls. Full length, collapsible tripod. Case. Optically and mechanically perfect. Paul Rubey, 2427 W. 6th St., Los Angeles 5, Calif.

FOR SALE: Chance Bros. 4½" refractor crown and flint blanks—prewar. Slabs B&L ELF-1 and BSC-1. Also several fused quartz blanks. H. E. Bussey, 4242 Wieuca Road, Atlanta, Ga.

GERMAN artillery and aircraft 10 x 80 binocular on tripod with vernier controls. $110.00. Magnetic Tape Recording Co., 103 Westminster St., Providence, R. I.

TELESCOPES & ACCESSORIES: If you want good optics and accessories for your astronomical studies, send for our catalogue. We will also submit prices on photometers and associated equipment for stellar photometry. Laboratory Optical Co., 76 Interhaven Ave., Plainfield, N. J.

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury reaches greatest eastern elongation on January 18th, a favorable apparition although the planet is only 18° 45′ from the sun. The planet will then set nearly 1½ hours after the sun, and be easily discernible to the naked eye. Mercury may be found as early as the first week of January, setting one hour after sunset and of magnitude −0.7.

Venus, no longer prominent, rises in the morning twilight. On the morning of January 26th, a rather rare close conjunction of Jupiter and Venus may be observed. The pair will have a separation of only one minute of arc, and appear as one object to the unaided eye. Binoculars will be essential to separate the planets. The telescopic view will be magnificent: Jupiter will be 30″ in diameter and twice this distance to the south one will see the brighter disk of Venus, 11″ in diameter and almost circular. This conjunction occurs at 8h UT; however, three hours later, the rising time in the eastern United States, its appearance will be very little changed. Dawn will interfere with attempts to photograph the configuration, but with a telescope and projection through an eyepiece into a camera box one should be able to get some results.

The following morning the crescent moon, two days before new, will pass 5° south of the two planets, which by then will be 5′ apart.

Earth is at perihelion on January 3rd, at 14h UT. Its distance from the sun is then 91,400,000 miles.

Mars cannot be seen due to its proximity to the sun.

Jupiter and the sun are in conjunction on January 1st, and by the end of the month the planet will become visible in the morning sky, rising an hour ahead of the sun.

Saturn rises during the early evening hours, and is the lone planet visible most of the night. It is now retrograding, about 6° west of Regulus in Leo, brighter than the star.

Uranus, above the horizon all night, is located 3° west of the star 1 Geminorum and 5° northeast of Zeta Tauri. This distant planet is 6th magnitude, and continues to move retrograde.

Neptune arrives at western quadrature to the sun on January 5th, hence rising about midnight. It is almost stationary all month at 12h 58m, −4° 31′ (on the 15th), about 2° west of Theta Virginis.

E. O.

VARIABLE STAR MAXIMA

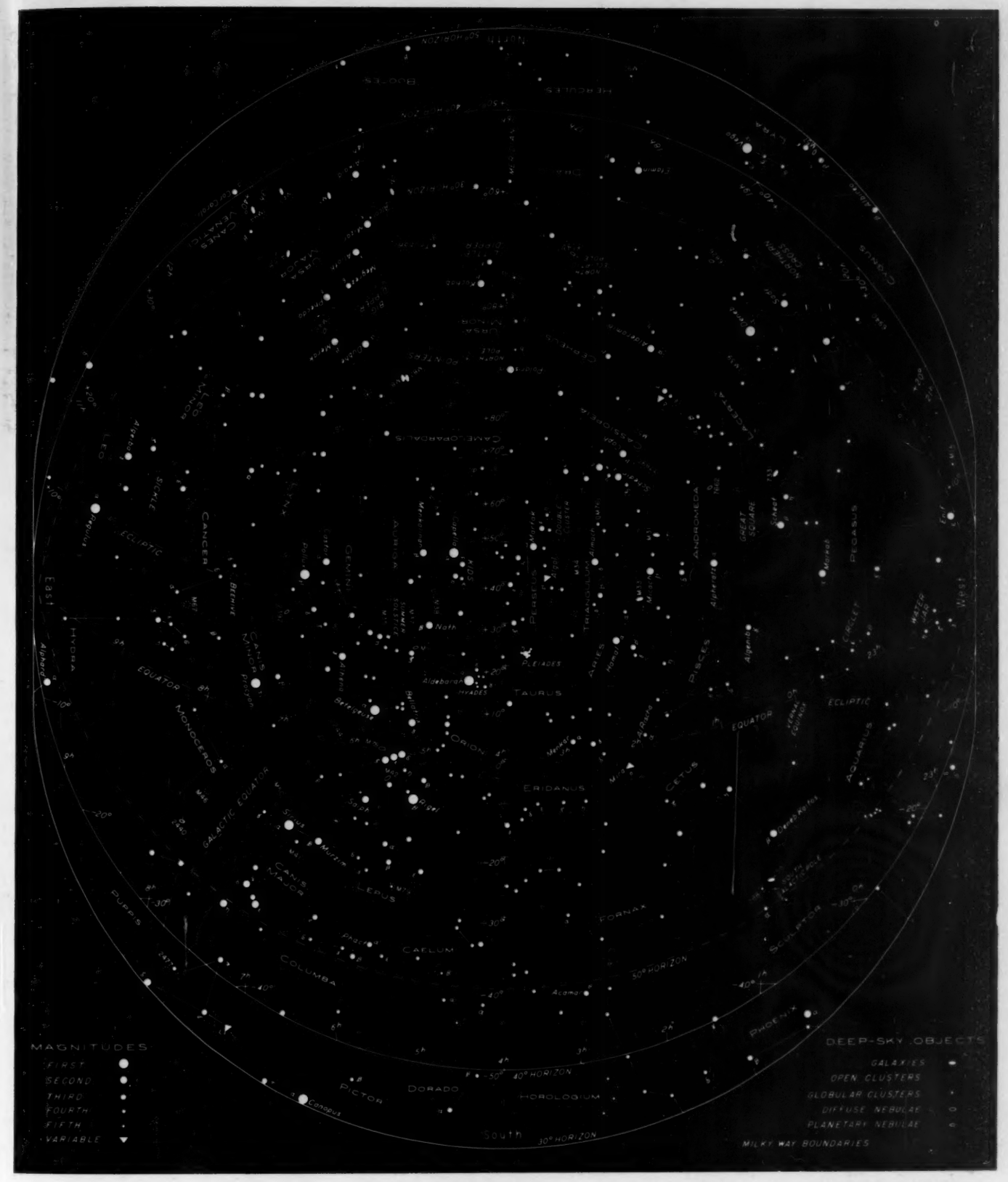
January 2, T Hydrae, 7.7, 085008; 8, R Doradus, 5.0, 043562; 10, R Ursae Majoris, 7.6, 103769; 12, V Monocerotis, 7.2, 061702; 13, R Horologii, 6.0, 025050; 16, U Cygni, 7.0, 201647; 17, R Delphini, 7.6, 201008; 20, R Trianguli, 6.3, 023133; 22, T Centauri, 6.1, 133633; 23, R Andromedae, 6.9, 001838; 30, T Herculis, 7.8, 180531.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

CORRECTION

Richard Widner, of Portland, Ore., writes: "In the October, 1948, issue of **Sky and Telescope**, on page 314 under Deep-sky Wonders, NGC 7331 is listed as a barred spiral galaxy. According to Jeans, **The Universe Around Us**, NGC 7479 should be the barred spiral instead of NGC 7331 [which is of type Sb, a normal spiral of intermediate type]."



STARS FOR JANUARY

AGAIN we resume monthly publication of **Sky and Telescope**'s regular star charts. During 1948, 12 simplified charts were published, with black stars and lettering on a white background; some lesser constellations and most of the deep-sky objects were omitted.

The chart above shows all stars to magnitude 4.20, with some fainter ones included to complete such well-known configurations as the Little Dipper, and to make up faint constellations which contain only 5th-magnitude stars. In each constellation the Greek letters are given from Alpha to Eta, and sometimes others on important stars. Many star names are shown, although no attempt has been made to include all the known names. For the Belt of Orion, for instance, space does not permit the inclusion of the names.

Deep-sky objects are of several kinds, as shown on the key; they are indicated by Messier numbers or, lacking such, with their numbers in the **New General Catalogue** (NGC). The boundaries of the Milky Way are dotted.

This chart has been drawn to be used from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.

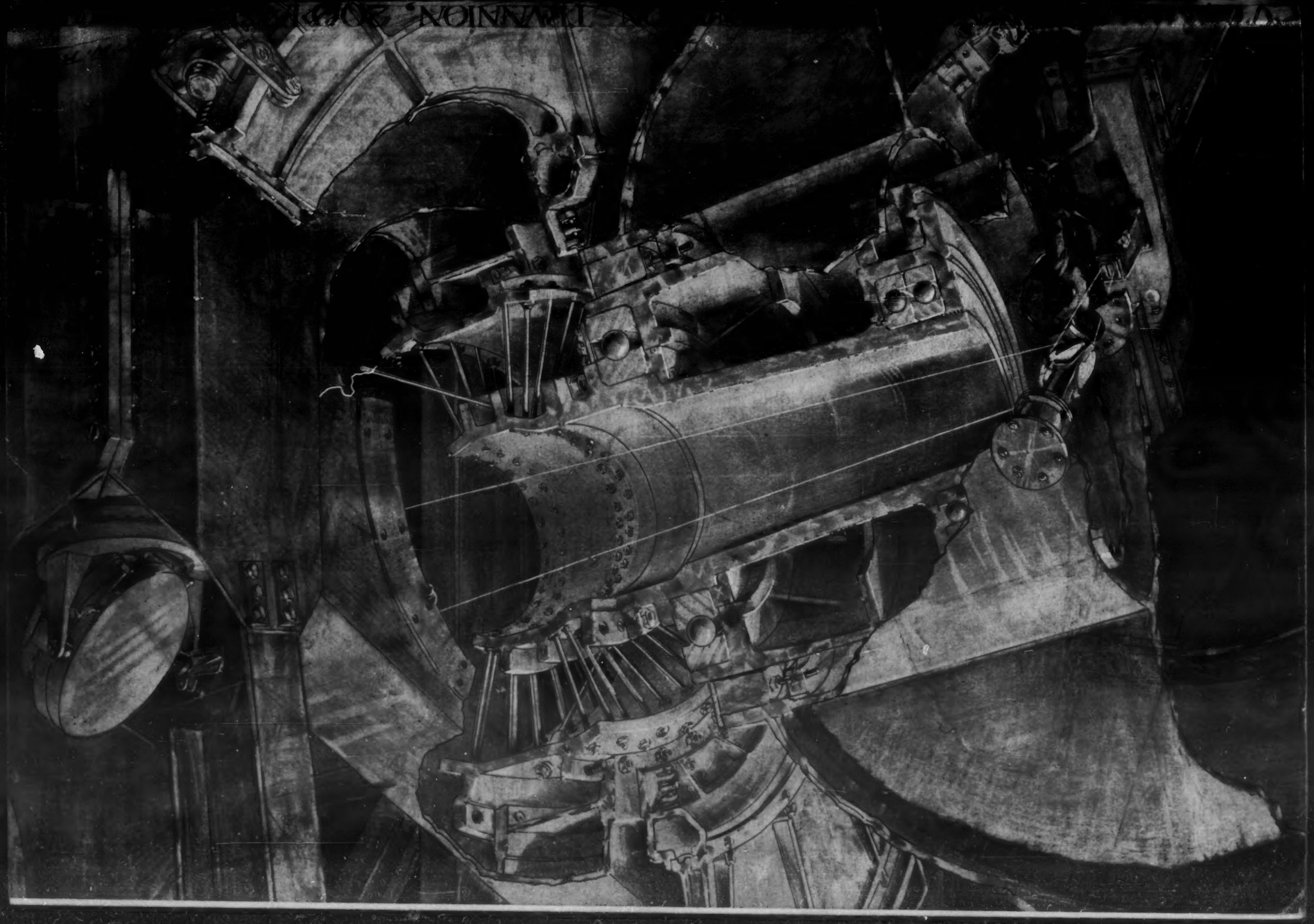



Chart correction: Beta and Gamma Lyrae should be reversed.